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ORGANISATION AND MANAGEMENT IN NATIONAL INDUSTRIES

THE general lessons to be learned from the experience of the coal industry under national ownership in Britain are clearly of great importance and wide interest in view of the prominent position in the Government's programme for nationalization of industry. A certain amount of material is already available. Sir Charles Reid contributed a series of important articles to *The Times* last November, and now a useful report, "The Organisation of the Coal Board", by Colonel C. G. Lancaster, has been issued by the Conservative Political Centre. The National Coal Board has prepared a statement on what it describes as the "main recommendations" of the committee set up under the chairmanship of Sir Robert Burrows to investigate the organisation of the Board; the reason given for not publishing the complete report is that it "would not be in the best interests of the industry". This ignores the large section of public opinion which is concerned to observe impartially the results of this great experiment in public ownership, with the view of remedying whatever defects of organisation, equipment or other matter that may be revealed, and of seeing that any further experiments in nationalization should be able to avoid the same mistakes. The decision to withhold full publication consorts ill with a Government policy which has established the British Institute of Management and is pressing for higher standards of management in industry.

It is the general lessons to be drawn from the experience of the coal industry that are so important at the present time; nevertheless, the question of public responsibility and accountability which public ownership implies should not be allowed to go by default.

From what has been disclosed of the recommendations of the Burrows' Committee, it seems clear that the original organisation of the National Coal Board was defective; and that some of its difficulties would have been avoided had a more decentralized structure been adopted at the start and one less calculated to destroy the sense of individual responsibility in an industry which, like many others, has depended on personal energy and enterprise. Even with the most perfect organisation, it will not be easy under public ownership to preserve the sense of individual responsibility which is so important a factor in preventing the rise of costs, the elimination of waste of materials or of man-power. The proposals made by Sir Charles Reid in his articles are designed primarily to provide an organisation which insists on personal responsibility at all levels, so that waste in whatever form can be immediately checked and eliminated. Incidentally, they would make the scientific staff merely advisory to the twenty-six operating bodies which would replace the present eight divisions, with the management of research stations as their major work. As Sir Charles observes, character develops with responsibility, and a man

will only give of his best when he has complete charge of his job and is trusted to perform it.

The similarities between the internal and the external criticisms of the organisation of the National Coal Board do not conceal a difference in the emphasis laid on the bearing of organisation on the present state of the industry. The transfer of ownership has not given the output that was expected or is essential, and mechanical improvements have not brought productivity above even the pre-war level. Unsatisfactory output and a high level of absenteeism have, moreover, been accompanied by the marketing of very inferior coal, which may to some extent falsify even the output figures, low as they are.

Differences of opinion may exist as to the exact responsibility of organisation for such weaknesses, and as to the most appropriate measures by which to remove them in the coal industry itself. Nevertheless, there is general agreement that there has been confusion in the working of the Board's policy, faulty liaison, lack of clarity in the 'channel of command', and an absence of full understanding and mutual confidence between the different units of authority and between the different departments. The public interest, therefore, demands that there should be full and public discussion of this problem of the organisation of nationalization in industry in time to prevent the repetition of like mistakes elsewhere. Nor can it be said that this is simply a matter of organisation. It is equally a question of management. Fundamentally, it is a question of how to secure the leadership in industry which will simultaneously ensure efficient production, the loyal and full co-operation of all engaged in it at every level, and a high standard of service to the general public which uses the products of industry.

Much is involved in this question of leadership in a free society. It involves industrial psychology as well as the study of administration. The problem of incentives is not one in which we are content just to study people at work and the relations between them and the situation at work: we must study also the people who work as individual human beings, whether they are managers, technicians, craftsmen, skilled or unskilled labourers. We must also study the society as a whole in which they are working; for its conditions can affect incentives just as strongly as those group relations within the factory on which the investigations at the Western Electric Co. have laid such stress.

There, indeed, we are passing into the wider field of social science, and are concerned with moral and spiritual as well as with material factors. This is one reason why the report of the Present Question Conference at Magdalen College, Oxford, last August on "The Problem of Leadership in a Free Society"* is so timely. Here once again is reiterated the need to take full account of the total social and industrial situation in which the workers in any particular firm or organisation find themselves. Incentives and deterrents, for example, can only be judged against the background of social reality, taking account both of the social setting and of individual attitudes. It is scarcely possible to avoid in modern industry some degree of remote control. The real question is the extent of such control, and how to secure, simultaneously, adaptability and flexibility and the spontaneous co-operation which is vital in efficient production.

The major part of the third Present Question Conference was devoted to a discussion of leadership in industry initiated by Mr. W. B. D. Brown, the other major contributions being those of Prof. D. M. Mackinnon on the leader and the idea, and of Dr. J. H. Oldham on leadership and society. All alike put men and women as persons into the centre of the problem, but stress the need for reconciling the needs of the individual with those of the smaller and larger groups of which the individual is a unit and which permit both the expression of individuality and the growth of units and social groups. Much that Mr. Brown has to say about leadership in industry, particularly on joint consultation and the like, is to be found in other words in Mr. F. J. Burns Morton's recent book "Team-work in Industry"; but he brings out even more clearly the way in which with the passing of autocracy there must be a keener and more widely diffused sense of responsibility among all engaged in industry.

That is the condition of industrial democracy; and Prof. Mackinnon, pursuing much the same theme, shows how this question of freedom in industry is linked up with the idea of service. It is implicit in the idea of leadership; and while both industry and society require leadership of all kinds and at all levels, it is leadership of a type, not indeed unknown or even rare in history, but alien from that in which the idea of domination or autocracy prevails. It is the leadership of which Arthur Bryant wrote in "Years of Victory": not a mere matter of transmitting orders but of evoking the will to serve. It is the quality which, as Dr. Oldham insists, inspires men and women, and secures the constant but spontaneous co-operation of others in raising the standards of society and in the pursuit of excellence. It means leaders who are capable of understanding the common or group mind, and who, while taking account of scientific and technical factors in industrial or social problems, are not dominated by them.

Dr. Oldham's words here need to be weighed by those who are inclined to exaggerate the importance of a scientific approach, and to look to the use of the scientific method alone to solve our social and political problems. Dr. Oldham recognizes our great need of more knowledge especially in the field of the social sciences, and that there are important problems capable of technical solutions; but he insists that fundamental problems of human society to-day are not the technical problems. They are problems of equilibrium between competing interests, the distribution of power and the restraint and responsible exercise of power. They require for solution not knowledge or technique but the wisdom which is the mark of the statesman.

The question of moral and spiritual power arises here, and that involves a question of values—that

* Question. Vol. 1, No. 2. Winter, 1948. (Present Question Conference, Ltd.) 2s. 6d.

persons are prior to things. The Present Question Conference is a challenge to the materialism and the false scale of values which have been responsible for so much that is wrong and weak in industry to day. Some of these weaknesses are shown in greater detail by Mr. Burns Morton in the book already referred to. They will not be eliminated altogether by new techniques of co-operation or forms of organisation, but only as some moral or spiritual force takes possession of individuals and groups and binds them together in the same sense of fellowship and service to a great cause as we witnessed in Britain under great leadership in the summer of 1940.

This is no new conception of leadership. Colonel L. Urwick has brilliantly expounded Mr. Ordway Tead's definition of leadership as winning the will to co-operate from those whose co-operation is needed, and making the purposes of the joint undertaking explicit and continuously attractive to those who share the burden of attaining them. We have still far to go before that conception finds adequate expression in industry, whether nationalized or not, and it is a conception that applies to leadership both at the lower levels and at the highest ranks of management. The social scientist and industrial psychologist have undoubtedly still much to contribute in this field and may help us to understand more clearly the causes of past failure and to devise new ways or techniques of overcoming them. But what is needed is not so much new knowledge as the wise and resolute application of much that is already known and even familiar. We need the driving force of a common purpose and a common ideal, and it is in this conviction that Sir Stafford Cripps writes in his foreword to the report of the Present Question Conference: "We can hope for but little from our future unless we are prepared to place behind all our efforts our full spiritual power and force. More and more it is brought home to me in all my work that it is the moral strength of high spiritual standards that must give us the courage and determination to solve our many problems in the social, economic and political fields. Let us not be afraid to proclaim and to act upon the faith that is ours, faith in the power of the spirit of man to control the material resources at his disposal."

LORD RUSSELL'S THEORY OF KNOWLEDGE

Human Knowledge

Its Scope and Limits. By Bertrand Russell. Pp. 538. (London: George Allen and Unwin, Ltd., 1948.) 18*s*. net.

LORD RUSSELL interprets human knowledge narrowly. He deals with scientific knowledge and takes it to be, for the most part, mathematics and physics, along with the cruder common-sense knowledge on which they are based. He admits, indeed emphasizes, that psychology is in some respects a distinct discipline, which has to be taken into account and has a certain primacy. Granted these limitations, which are certainly convenient for exposition, the book is a masterly and comprehensive piece of work. It contains, in the reviewer's opinion, far the best treatment that has yet appeared of the problems of inductive generalization. This is the central theme of the book and one on which Lord Russell has barely touched in previous books. There is a discussion of language (Part 2) intended to clear up ambiguities and dispose of fallacies, not very different from that in his "Inquiry into Meaning and Truth". There is a valuable section on probability (Part 5) which is intended to specify the useful but subordinate part which the mathematical theory of probability plays; subordinate, because mathematical theory cannot be applied unless the basic problem of induction is taken as solved already, and because another non-mathematical notion of 'credibility' is required.

The central problem may be stated as follows. It must be granted that the sciences exist and form a body of knowledge which, though incomplete and largely tentative, is growing and claims to be valid; not in the sense of being infallible, but immeasurably better than any alternative. The claim to validity cannot be treated solely as a question of formal logic, for it is a claim that *this* body of factual knowledge is valid because of what it is; not any knowledge or even any like knowledge. We must therefore consider in outline what the sciences say about the world, how this alleged information has been acquired, and then evaluate it.

In the course of the first two inquiries we find that the most advanced scientific thought has its roots in what Lord Russell calls animal inference, or habit. If the tendency of animals to form habits had not run parallel with some sort of habit in their environment, they would not have survived. The utility of advanced scientific knowledge is a continuation of the process of adaptation through habit. Hume was content to leave the argument at this stage, because, after the eighteenth-century manner, he drew a sharp distinction between reason and animal habit, which the twentieth-century thinker sees no reason (or is not habituated) to draw. Lord Russell goes on to formulate minimum postulates which will validate existing scientific thought; or, to put the matter differently, what is the least assumption we can make about corresponding cosmic habit and mental habit to justify our continuing our habitual behaviour in future. He rejects phenomenalism because the physical process of radiation implies that between two observed events something can happen, which by hypothesis is not observed; in short, there cannot be continuity in the world if only observed events exist. He rejects pure empiricism because there must be some general principles, not just particular facts. To develop his system of postulates he uses the notion of 'structures'. The concept of structure may be logical in its origin, as he says; but it is certainly put to empirical use. A special but crucial example will illustrate what would justify such use. When we look at the full moon, is there literally, not metaphorically, the same kind of circular structure in the immediate datum of experience, in the astronomical object, in the intervening physical processes of radiation between the moon and our bodies, and in the physiological processes inside our bodies? If we can postulate such isomorphism (as Kohler calls it) it is easy to establish a theory of perceptual and scientific knowledge. But if we do, are not such isomorphic structures of the nature of Platonic forms, archetypes which make things what they are and also make them knowable? In recent writings Lord

Russell has fought shy of a realist view of universals, though never committing himself to nominalism. It looks as though he had returned to earlier views (as in "The Problems of Philosophy") or gone further still in realism.

Lord Russell puts forward his postulates as validating scientific knowledge. To anyone who objects that he has never believed them or even thought of them and does not see why he should, what is Lord Russell to reply? Within the bounds of Hume's philosophy there is no reply except the kind which Hume himself supplied inadvertently. In the very process of dismissing causality as illusory, Hume used the notion of cause. The other reply would be a 'transcendental deduction of categories'. Would Lord Russell desert Hume's camp, where he has dwelt so long, for Kant's; and after all the hard things he has said about Kant? Or is there another alternative?

Some few minor complaints can be made about Lord Russell's discussion. He assumes that experience begins with a private ego-centric space, and he does not explain how, from that starting point, we can ever arrive at the public universal space required by physics. There is a chapter on the principle of individuation; but the problem is shelved rather than solved.

After all allowances for blemishes have been made, this remains a very fine and characteristic piece of work; written, too, with all the clarity, wit and gusto we have learned to expect.

A. D. RITCHIE

AMERICAN USES OF GROWTH REGULATORS

Growth Regulators for Garden, Field and Orchard

By John W. Mitchell and Paul C. Marth. Pp. vii+129. (Chicago: University of Chicago Press; London: Cambridge University Press, 1947.) 15*s*. net.

THIS book deals with the practical application of plant growth regulators in agriculture and in horticulture; it has the initial merit that its authors have richly contributed to the studies of such applied science. In a very short section an introduction is effected to the various groups of available chemicals tabulated according to their chemical affinity; for readers unfamiliar with recent progress this section could with advantage have been enlarged to include some consideration of the mechanism of the responses involved and some analysis of the reactions induced. But proceeding apace, the authors review the value of '2, 4, D' and 2, 4, 5, trichlorophenoxy acetic acid as herbicides, giving long lists of the resistant and susceptible plants, using only their common American names. But the discussion briefly deals with factors that influence the effectiveness of the chemicals; temperature and soil conditions are not overlooked, nor are precautionary measures neglected. Reports of the use of other such compounds, at lower concentrations, to facilitate the vegetative propagation of plants, form a large section of the entire work, and the lengthy tables show many responsive plants and details of treatment. Botanical names and common names assist the reader here. Perhaps a critical discussion of the after-effects of certain substances, effective in root formation, but tending to delay bud development when used at rather too high concentrations, would have increased the value of this section. The use of esters of naphthalene acetic acid—intentionally—to inhibit the development of buds and 'sprouts' is well described, and here British readers will see that roses are so treated under American conditions of marketing the plants. The storage of potatoes may be prolonged without sprouting; as there is always a chance that tubers meant for planting may be cooked, it is reassuring to read that no 'off' flavour nor any ill-effects were observed when such were used boiled or as chips! Although young fruit trees have been retarded to some extent, without injury, it has not yet proved practical to delay the opening of fruit buds to avoid possible damage by frosts.

Paul C. Marth has been a pioneer in the use of growth substances to control the pre-harvest fall of fruit from the trees, and the review of the use of water sprays, of dust carriers, and of other methods of application, including the use of aeroplanes, is a valuable feature of this book, as are also the remarks concerning the importance of correct timing of the treatments. Naturally, the discussion of varietal responses centres around well-known American kinds and does not include much concerning British varieties.

A short chapter is included on the use of ethylene and other substances for accelerating the ripening process of bananas and citrus fruits. Similarly there is mention of the use of di-nitro-*ortho*-cresol and di-nitro-*o*-*cyclo*hexyl-phenol to thin out fruit blossoms, although these chemicals do not fall within the category of active growth substances as generally understood by British workers. The use of β-naphthoxy acetic acid and other compounds to produce seedless fruits is discussed.

The illustrations are good and helpful. There are lists of available American proprietary preparations given at the end of the chapters.

We have for long appreciated the work of the university presses concerned, and another example upholds the standard they set.

M. A. H. TINCKER

COLOUR

The Color of Life

By Arthur G. Abbott. Pp. xxi + 294 + 7 plates. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 6 dollars.

COLOUR in life is inescapable, though some, being more observant, see more of it, especially the colour of natural things and natural phenomena, than others. Colour always has been and always will be associated with various arts and crafts in which the colouring agency such as dyestuff, as in the colouring of textiles, or the pigment, as in painting is often man-made as well as man-assembled. Many of the great men of science since the time of Newton and his contemplation of the rainbow have been concerned with colour and have sought to explain just what colour is. Many are the known facts and theories about colour, for indeed the subject can be approached from many aspects. Thus the characterization of colour by mathematical symbols gives satisfaction to some, whereas others believe that the psychological effects of colour are the more worthy of study. Altogether there is to-day a greater and more widespread colour-consciousness, more appreciation of colour in Nature and in the broad activities of everyday life than ever before. It finds practical expression, for example, in the painting of factory walls and

machines, in which colour now contributes to safety and eye comfort as well as to cleanliness and decoration in the ordinary sense.

The author, recognizing these things and clearly being fascinated by the subject, has sought to present its enormous sweep in a series of cameos in twenty chapters arranged in six groups under the following headings: 1, foundations of colour—light, matter and sight; 2, colours by Nature and how produced; 3, colours by man and how produced; 4, guides to use of colour—colour terms and names, harmony and discord in colour combinations; 5, colour for everyone—apparel and building; and 6, relation of colour to man's progress—special uses of colour.

In the result the substance of each chapter is a précis, or in some cases a partial abstract, of the reference books listed at the end of each chapter. At this point it is only fair to repeat some of the author's introductory words, namely: "This book is not intended to be a guide for any science, trade or profession, but a source of pleasure and profit for the average man, woman and child . . . to present a variety of facts, theories, experiences and observations about colour that will be interesting and useful. . . ."

There remains the question of accuracy. Are the factual statements which the author has made correct? On this I have to record that the chapter entitled "Paints" shows some confusion of thought, though comparatively little editing would have removed any cause for complaint. After all, it is not reasonable to be able to describe all the pigments, white and coloured, and the principles of paint manufacture, in nine not very closely printed pages. On the other hand, I was intrigued to read among a multitude of 'titbits' about a great variety of subjects that turkey flesh should have no purple tinge, as this marks an old bird—I shall examine my next turkey with added interest.

L. A. JORDAN

TREATISE ON ZOOLOGY

Traité de zoologie

Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 11: Échinodermes, stomocordés, procordés. Par P. Brien, M. Caullery, L. Cuénot, A. Dalcq, C. Dawydoff, P. Drach, H. Harant, G. Waterlot. Pp. viii+1,078. (Paris: Masson et Cie., 1948.) 3,800 francs.

TO older zoologists the title "Traité de zoologie" will recall the extensive work published by Prof. Edmond Perrier, the first volume of which appeared in 1893. It held its place on the bookshelf for many years, and even now some parts bear reference; but obviously in fifty years a vast amount of water has flowed under the bridge. The present work has a similar format and 'get up', but has a striking difference in that it has ninety-three collaborators from France, Belgium, Switzerland, Algiers, Egypt and Morocco, united under the direction of Pierre-P. Grassé, professor at the Sorbonne. This new treatise is planned to extend to seventeen volumes, each of which will consist of about 1,000–1,200 pages and will be fully illustrated.

The publication of such a large work has dangers not encountered in issuing a single large volume, or a small number of volumes. It may spread over such a long period that the first volumes are quite out of date before the last ones appear, so that it does not form a usable whole; or it may suffer the fate of Lankester's "Treatise", Délage et Hérouard, or Kükenthal und Krumbach, which were never completed. It is to be hoped that the present commendable work will avoid these dangers, and the fact that a large number of authors are collaborating may help. Four more volumes are scheduled to appear in 1949, and at least three in 1950; and if this rate is maintained the work should be completed in little more than four years, a not unreasonable time. The large number of contributors should also make it possible for each section to be up to date and authoritative, for it is obviously impossible for one or even a small group of authors to cover adequately the vast field of modern zoology.

The volume at present under review, while it is number 11 in the series, is actually the first to appear, and so may be taken as a sample of those to follow. It contains 1,078 pages with 993 figures, 11 of which are in half-tone, 11 reinforced by colour, and the remainder in line block; they are deserving of high praise. The volume deals with the systematics, anatomy and biology of the Echinodermata, Stomochorda (Hemichordata) and Prochorda (Tunicata and Cephalochordata). Each section is provided with its own bibliography, which varies in extent according to the availability of recent bibliographies. The principal contributors are Profs. L. Cuénot (Nancy), C. Dawydoff (Paris), P. Brien (Brussels) and P. Drach (Sorbonne). The group Stomochorda is set up because the pharyngeal diverticulum lies near the mouth, and it is held that this is a structure *sui generis* and is not strictly homologous with the notochord of the true chordate. The structure itself is referred to as a stomochord (stomocord) to emphasize this distinction. The recent researches of O. M. B. Bulman and Kozlowski, taken fully into account, show that the Graptolites are more closely allied to the Pterobranchia than they are to the groups with which they have been associated previously, the Sertularian Hydrozoa or the Bryozoa, and consequently they have been included as a class of the Stomochorda. Cuénot has a discussion (pp. 359–361) of the relationship of the dipleurula of the Echinoderms to the tornaria of the Enteropneusts, and of the basic trimerism of the former phylum as indicated by the development of the cœlom. This, read in conjunction with the fuller discussion by Dawydoff of the Stomochorda and their affinities (pp. 511–532), shows clearly that both authors recognize an ancestral relationship between the Echinodermata and the Stomochorda, and, of course, the latter are clearly related to the Prochordata. Thus the three groups are logically included in the same volume.

On the whole the book is excellently printed and illustrated, and the paper is very good. A detailed index is furnished and a very full table of contents which is placed right at the end of the volume. It is a pity that a number of slips have been allowed to pass uncorrected, for example: p. 297, deutoplosme for deutoplasme; p. 362, Mac Millan for Macmillan; p. 488, McIntosch for McIntosh; p. 452, Bulloc for Bullock; p. 947, fig. 407, *e* in the diagram is *Fe* in the legend; and p. 494, fig. 408, *v s* in the diagram is *vis* in the legend, etc. Apart from these, the authors, editor and publishers are to be congratulated on initiating a series of volumes that should prove most useful to all zoologists, and we wish their venture every success.

C. H. O'DONOGHUE

Medicine and Science in Postage Stamps

By W. J. Bishop and N. M. Matheson. Pp. 82 (33 plates). (London: Harvey and Blythe, Ltd.; H. K. Lewis and Co., Ltd., 1948.) 7*s*. 6*d*. net.

WHILE the emphasis in this little book is on medical interest, the authors also refer briefly to scientific workers in the widest sense who have been commemorated by special stamps; among whom are Tycho Brahe, Ampère, Descartes, Linnæus, Mendel, Berthelot, Edison, Marconi and the Curies. The book contains a 16-page account of the reasons for the issue of such stamps; there are short sections on portrait stamps, Red Cross stamps, various tuberculosis stamps, illustrations of hospitals and other medical institutions, the use of medical symbols and apparatus, and other stamps of medical interest. There follow thirty-three plates giving black-and-white reproductions of 148 such stamps from the authors' collections. The book ends with 23 pages of biographical notes, arranged alphabetically, relating to the portrait stamps mentioned. There is also a bibliography.

In addition to stamp collectors among the medical and related professions to whom the book is specifically addressed, it may well arouse interest in this instructive hobby among others interested in scientific developments.

Meson Theory of Nuclear Forces

By Wolfgang Pauli. Second edition. Pp. vii+69. (New York and London: Interscience Publishers, Inc., 1948.) 12*s*.

THIS second edition differs from the first (reviewed in *Nature*, **160**, 418; 1947) only in a few short sections, where instead of older experiments some more recent ones are discussed (concerning the angular distribution of proton-neutron scattering, p. 56, and the consequences of strong coupling theory, p. 64). The most interesting feature of the new edition of the little book is its preface, where the author refers to new discoveries incompatible with the present theory, such as the existence of different kinds of mesons and the absence of negative meson capture by the lighter nuclei. He hopes that artificial production of mesons recently achieved in the United States will bring forth a great change of the whole situation in the near future.

Isomerism and Isomerization of Organic Compounds

By Ernst David Bergmann. (Polytechnic Institute of Brooklyn: Lectures on Progress in Chemistry.) Pp. xi+138. (New York and London: Interscience Publishers, Inc., 1948.) 21*s*.

THIS little book presents the material of six lectures delivered by the author during 1945–46, and deals only with those aspects of its subject which have most interested him. This limitation is made clear in the preface, and the would-be reader should not be misled by the wide title of the book into expecting even an outline of the whole field. The book is a very personal approach to the subject, and presents an individual outlook which will probably not commend itself to the majority of qualified readers; thus, it will surprise many to find, in a chapter entitled "Mechanism of Substitution Reactions; Racemization and Walden Inversion", only one reference, and that purely experimental, to the work of Ingold and his school. Some of the theoretical interpretations are also highly individual and will be regarded by many as very questionable; for example, the surprising statement (p. 119) that, in the rearrangement of phenyl allyl ether, "a van der Waals' link is established between the unsaturated γ-carbon atom and the ortho position". Although, as the author hopes in his preface, the book may provide "food for thought" for the critical reader, it is certainly not suitable for students, and from this point of view its high price is to be welcomed.

H. N. RYDON

The Faith of Reason

The Idea of Progress in the French Enlightenment. By Charles Frankel. Pp. x+165. (New York: King's Crown Press; London: Oxford University Press, 1948.) 16*s*. net.

FOR the philosophers of the French *Enlightenment* theirs were grand days. They were grand because the errors of history and of circumstance were at long last understood; reason would put everything right. Thus the enthronement of scientific method; the fields were white to harvest with the fruits of Cartesianism, all ready for the garnering; and this not necessarily against the winter, for such seasons would be mild in future, their edges rounded off by a generous humanity, which quality, by the way, was thought to be identical with reason itself.

The brilliance of these savants is beyond question; what seems odd to us now is their limited imagination, due in the main to a system of metaphysics telling them exactly what they were about to find, and keeping them in fetters while looking for it. Nevertheless, we are assuredly their debtors in the sphere of moral progress.

Much of the temper of the *philosophes* is of concern to society to-day, especially when the uses of science are subject to attack, and there is much talk of 'irresponsibility'. Dr. Charles Frankel, aided by the King's Crown Press, has performed a valuable service in producing this monograph. Between its covers can be found a critical, but not pedantic, account of an age at the moment somewhat neglected in the history of thought.

F. IAN G. RAWLINS

Shetland Sanctuary

Birds on the Isle of Noss. By Richard Perry. Pp. 300+32 plates. (London: Faber and Faber, Ltd., 1948.) 25*s*. net.

THE island of Noss on the eastern side of the Shetland group is a well-known resort of seabirds, the great cliff known as the Noup of Noss that faces the North Sea being a breeding place of countless kittiwakes, guillemots and razorbills, plus many gannets. In addition, great skuas and Arctic skuas nest on the grassy expanse of the island. These are but some of the bird attractions of Noss. The island well deserves the title of "Shetland Sanctuary" under which Mr. Perry describes it in his latest book.

In this book the author tells us of his five months work on Noss, during which he made his headquarters in the old farm-house, now, alas, falling into disrepair, while his wife and child found a less arduous habitation on the nearby island of Bressay. To appreciate the author's results one must read his careful studies of the great skua, the Arctic skua and the gannet, with sidelights on many other birds. In the space of a brief review it is difficult to give much idea of them, and we must refer the reader to the book itself, which in our opinion is the best Mr. Perry has written.

F. P.

COCOA DISEASE IN THE GOLD COAST

FOR some years past, increasing uneasiness has been felt about the future of cocoa in West Africa and particularly in the Gold Coast. Trees began to die in ever-increasing numbers, and at first the trouble was attributed to 'die back' and physiological troubles, due to the excessive removal of high forest which occurred during the rapid opening up of the country for new plantations. This it was believed let in the dry 'harmattan' winds from the Sahara, causing a less favourable environment for the cacao tree. As a remedial measure the establishment of shelter belts of high forest was recommended, and in due course they came into being; but the trouble still continued to spread and remained an unsolved puzzle until one of the scientific officers, stationed on the newly opened Cacao Research Station, established that the cause is a virus disease. The research station is situated at Tafo in the middle of one of the badly infected areas of the Eastern Province, and was opened about ten years ago. It has done valuable work in establishing that several types of virus are responsible, that infection is conveyed by particular species of mealy bugs, and that certain species of indigenous forest trees can serve as alternative hosts.

The Station has also devoted much attention to methods of control and has come to the conclusion that the basic method for dealing with a disease of this type is the removal of sources of infection. This means cutting out not only trees that are obviously beyond hope of recovery, but also trees that show symptoms of the disease but are still bearing some fruit. Most of the cocoa farmers are poorly educated men, with only two or three acres apiece, and it naturally went against the grain to ask them to destroy trees that were apparently still capable of producing a few pods, especially at the present time when prices are exceptionally high. Attempts to apply this 'cutting out' cure have been unpopular and have been strongly resisted by the growers. Unfortunately also, local politics were dragged in, so that serious disturbances took place in March 1948, with the result that the legal powers to compel cutting out, which already exist, have not been enforced. For nine months or more the disease has to all intents and purposes been allowed to spread unchecked, for the cutting out campaign has been suspended.

As a consequence of these events, a special commission was sent out by the Colonial Office in May 1948 to report on the disturbances, and acting on one of its recommendations, a panel of three plant pathologists of international repute, drawn from countries not commercially interested in cocoa growing, was selected to study the disease and report on its control or eradication. These men were appointed to the commission after consulting the United Nations Food and Agriculture Organisation, and their report has now been issued*, giving an entirely independent and up-to-date account of the cocoa position in the Gold Coast. In the first place, they entirely endorse the conclusion reached some years ago by the West African Cacao Research Station at Tafo, that cutting out is, at present, the only practical control measure. They point out the magnitude of the problem involved, as this means cutting out at least fifty million diseased cacao trees and several million wild host trees. Nobody knows how many cacao trees there are in the Gold Coast, but the figure may be of the order of 400 million; under these proposals, therefore, it seems probable that one-eighth of the existing cacao trees would have to go. So far, under the existing voluntary cutting-out scheme, not more than three million trees have been removed.

The urgency of the problem is emphasized since the disease is spreading at the rate of fifteen million trees a year, and has recently made great headway, because control measures have practically ceased since the March riots. The Eastern Province was the first area affected, and large blocks of cacao have been killed in what was formerly the most productive cocoa belt. The disease has spread to Ashanti, where former isolated outbreaks have extended to an alarming degree. The Western Province is still more or less in the period of sporadic outbreaks, but there is every prospect of its following the other two provinces unless adequate measures are taken. The Commission points out that far more vigorous action will have to be taken if there is to be any hope of saving the industry. Not only will the staff of the Agricultural Department need to be greatly strengthened, but means will have to be taken to bring home to all sections of the public the urgency of the matter and the definite threat to the whole industry, on which depends ultimately the prosperity of the entire country; for the Gold Coast relies to a frightening extent on the revenue obtained from its cocoa crop.

The Commission recommends, therefore, that the first and most important task is to educate all classes of the population to the seriousness of the position, and to secure their support for the 'cutting out' campaign. Until public opinion has been educated up to this point, it will not be easy to carry out the drastic campaign envisaged. It must be remembered that cocoa in the Gold Coast is produced by many thousands of peasants farming two or three acres each, or working land belonging to absentee landlords. The majority of these men are illiterate, and the difficulty will be to bring home to them the facts of the case. Something can be done by an extension of the radio system to the villages and markets; but the best way is probably personal conversation with a representative of the Government. Even a greatly enlarged staff in the Agricultural Department could only contact a small proportion, and it will be necessary for the campaign of enlightenment to be carried on by members of all Government departments, native authorities and chiefs' councils, and the Press.

It is obvious that, for the cutting-out programme to be effective, it must not only be vigorous but also thorough. It will be useless to treat most of the fields in an area and leave two or three untreated plots because the owners refuse to co-operate. These plots will be the cause of rapid re-infection of the neighbouring fields. Eventually it is hoped that public opinion will insist that all must play their part for the general good. It is obvious, however, that time will be needed to reach such a desirable state of affairs, and the need for a publicity campaign emphasizing the vital stakes at issue is all the more urgent.

* Colonial Office: Report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast. (Colonial No. 236.) Pp. 10. (London: H.M. Stationery Office, 1948.) 3d. net.

While endorsing the control methods of the Cacao Research Station, the Commission is inclined to think that the method of cutting out may need to be even more stringent if the disease is to be eradicated permanently from a particular area. It is pointed out that it is not sufficient merely to cut out trees showing signs of the disease; neighbouring trees that are in contact are also probably diseased, although they may not show symptoms until a later stage. The contact trees, therefore, will also have to go. It will be difficult to persuade the peasant farmer to cut out an apparently healthy tree by assuring him that it is the only way that his crop can be saved in the future. Since only a vigorous and thorough removal of infection sources can be expected to achieve a reasonable degree of success, the Commission thinks it advisable that the limited staff at present available should concentrate its efforts in areas of lesser infection, particularly Ashanti and the Western Province.

It may be that eventually the so-called 'raging belt' area of the Eastern Province, where the cacao fields have been practically wiped out, may prove to be the best place to resuscitate the industry, and at the same time replace the old methods by something more in keeping with the present time. In this area large areas of cacao have ceased to exist—only here or there a few trees struggle on. With the co-operation of the chiefs and their peoples, it might be possible to start new plantations on modern lines. This would entail the planting of cacao in large compact units instead of thousands of small scattered plots as at present. The area selected would have all existing cacao and wild host trees completely removed, and be left fallow for two or three years before replanting. The new area would be planted in rows at the most desirable distance apart, and this would enable spraying machinery to be worked if at any time action was needed in the future. At present, Gold Coast cacao is planted in a most haphazard way, and it is impossible to get into the crop to spray or prune.

A plantation of the type envisaged would have a relatively small periphery for its acreage, and border control of invasion from outside should be comparatively easy. There would be difficulties over land tenure and other customs, and these would have to be the subject of careful consideration and of goodwill on the part of the village authorities.

The fact remains, however, that one cannot envisage the Gold Coast succeeding in reviving its cocoa industry by relying on the old happy-go-lucky methods. There would be no guarantee that a crisis similar to the present one might not again arise. It is unimaginable that a disease of this nature could have got out of hand in this way if the crop had been properly cultivated and organised on a more rational basis. The present calamity that has befallen the Gold Coast cocoa crop may in the end, therefore, prove a blessing in disguise. If the growers are wise, they will take the opportunity of putting their industry on a sound basis. They will learn to treat their cacao as an orchard crop and not as a bit of jungle.

The establishment of plantations on the lines mentioned will enable modern up-to-date methods to be employed and better material planted. The research workers must have time to make their investigations; but already there are signs that higher-yielding, disease-resistant varieties may be forthcoming, and better methods of cultivation, fertilizing and disease control become available.

The Commission points out with reason that inadequate attention to the situation up to the present has allowed the disease to gain such headway that effective and immediate action is needed. One of the problems that as yet remains unsolved is the extent to which wild trees and plants are alternative hosts. It is known that the silk cotton tree, the cola and three or four species of Sterculiaceæ are carriers of the virus; but there may be others, and the search is still being continued. The destruction of some of these trees will present a big problem, for many of them are giants of 200 ft., with buttressed roots rising to 30 ft. in height. The possibility of destroying them by chemical means is being considered, but even so the task of killing several millions of such trees will be a stupendous one. The replanting of lightly affected areas will also prove difficult. It seems that more preliminary work is needed to ascertain the margin of time when it can be deemed safe to replant in lightly affected areas, from which a few diseased trees have been removed. Young cacao trees apparently show few signs of disease for the first three or four years, but after that, when their canopies become contiguous, they may become re-infected unless a complete sweep has been made of all possible sources of mealy bug infection.

The best hope for the future lies in continued research on the lines indicated in the report, coupled with a determination to re-establish the industry on rational lines; and for the present to attempt to alleviate the existing crisis by intensifying the 'cutting-out' campaign. GEOFFREY EVANS

RECENT ADVANCES IN THE CHEMISTRY OF HYDROCARBONS*

By Dr. S. F. BIRCH
Research Station, Anglo-Iranian Oil Co., Ltd.

THE demand for highly branched *iso*paraffins for use in higher-performance aviation fuels has stimulated research during the last ten to fifteen years into methods for producing such hydrocarbons in large quantities from available raw materials. Of the processes resulting from this work those based on isomerization and on alkylation are of outstanding importance.

In the isomerization process the molecular structures of the paraffins, particularly of the normal members which occur naturally in petroleum, are re-arranged to the required branched structures. Such re-arrangement is a reversible first-order reaction in which at low to moderate temperatures the equilibrium favours branched structures, but with increasing temperature the equilibrium shifts towards straight-chain structures. In the absence of catalysts the attainment of equilibrium is extremely slow even up to temperatures at which the hydrocarbons are thermally unstable, while in the presence of catalysts side-reactions become more marked as the temperature increases.

The most satisfactory catalysts for paraffin isomerization are the aluminium halides promoted by certain compounds such as hydrogen halides, alkyl halides, oxygen, water and olefins. These combinations are extremely active under relatively low-

* Substance of a series of lectures delivered at the Royal Institution, beginning November 16.

temperature conditions, apparently acting heterogeneously at liquid – liquid or liquid – solid interfaces. Since a promoter is necessary, the aluminium halide itself does not appear to be the catalyst. It has been suggested that acids of the structure $HAlX_4$ are the true catalysts, but this takes no account of the findings of Wackher and Pines that, in the isomerization of butane, traces of olefins, water or oxygen are necessary in addition to the hydrogen halide. Also, a recent study by Fontana and Herold[1] has shown that the vapour pressure of hydrogen bromide in contact with aluminium bromide is not abnormal, as it might be expected to be if such a complex were formed. The most plausible mechanism is that put forward by Wackher and Pines[2] on the basis of their work with partially hydrolysed aluminium halides. These workers found that the most effective catalyst was obtained by adding one molecule of water for each molecule of halide present, and, by using deuterium oxide in place of water, they were able to compare the rate of deuterium – hydrogen exchange between $DOAlBr_2$ and butane while the hydrocarbon was isomerized. The results of this investigation indicated that it is the bromine of the partially hydrolysed halide that takes part in the reaction, and accordingly the following mechanism has been put forward :

$$AlBr_3 + D_2O \rightarrow DOAlBr_2 + DBr$$

$$CH_3.CH_2.CH_2.CH_3 + DOAlBr_2 \rightarrow CH_3.CH_2.CHBr.CH_3 + DOAlBrH$$

n-Butane

$$CH_3.CH_2.CHBr.CH_3 \rightarrow (CH_3.CH_2.\overset{+}{C}H.CH_3)Br^-$$

$$(CH_3.CH_2.\overset{+}{C}H.CH_3)Br^- + CH_3.CH.CH_3 \xrightarrow{C_4H_{10}} (CH_3.\overset{+}{C}.CH_3)Br^- + CH_3.CH_2.CH_2.CH_3$$

CH_3 CH_3

*Iso*butane

In alkylation, highly branched *iso*paraffin molecules are built up by the combination of low molecular weight olefins and paraffins such as are normally available from refinery operations. Using a complex catalyst consisting of boron trifluoride activated by nickel powder and hydrogen fluoride or water, Ipatieff and Grosse[3] were the first to show that such a reaction is possible, although Parks and Huff[4] seem to have concluded some time previously from thermodynamical considerations that this type of reaction is feasible. It was next reported by Frey and Hepp[5] that such alkylation could also be effected non-catalytically under rather drastic conditions of temperature and pressure, 500° C. and 300 atmospheres ; thermal alkylation was, however, possible only with lower olefins and paraffins, except for methane and ethane, which have so far resisted all attempts, catalysed or uncatalysed, to react in this way.

Thermal alkylation has been employed technically to produce 2.2-dimethylbutane (*neo*hexane) from *iso*butane and ethylene on a comparatively large scale, but the greatest developments in alkylation processes have followed the use of the practical catalysts, aluminium chloride (activated with hydrogen chloride), sulphuric acid and hydrogen fluoride. Aluminium chloride possesses the advantage over sulphuric acid and hydrogen fluoride that it enables normal- as well as *iso*paraffins to be alkylated ; normal paraffins are presumably first isomerized to the *iso* form. Technically, aluminium chloride has been employed to produce 2.3-dimethylbutane ('di*iso*propyl') from *iso*butane and ethylene, a reaction that could not be brought about by the other two catalysts. This formation of di*iso*propyl rather than *neo*hexane as in thermal alkylation has been explained by Schmerling[6] on the basis of a chain mechanism involving the preliminary formation of an alkyl halide from the olefin and hydrogen chloride, leading to a *neo*hexyl structure which then isomerizes to the di*iso*propyl structure in the presence of aluminium chloride.

The most generally employed alkylation catalyst is sulphuric acid, hydrogen fluoride being used to a less extent. Both compounds are completely ineffective for the alkylation of normal paraffins, and their use is restricted to *iso*paraffins. The alkylation of *iso*butane with butenes has been the most important technical alkylation, although propene and pentenes have also been used. Schmerling has suggested a mechanism for sulphuric acid alkylation similar to that for reactions catalysed by aluminium chloride ; but this seems less likely, and the mechanism must still be regarded as obscure. The products from sulphuric acid alkylations consist of a complex mixture of *iso*paraffins boiling over a wide range of temperature, and under favourable reaction conditions the major part is of the desired molecular weight. By the end of the War, some 5½ million tons a year of *iso*paraffins were being produced by alkylation, and the process is still being operated on a considerable scale.

While isomerization and alkylation processes enabled most of the high-performance aviation fuels to be produced in vast quantities, one material, 2.2.3-trimethylbutane (triptane), could not be made in the required amounts by these methods, and it was necessary to devise alternative processes. Two solutions to this problem were eventually forthcoming. Thus Lovell and Miller[7], on the basis of an observation in 1882 by Eltekoff[8] that 2.3.3-trimethylbutene-1 was a by-product from the treatment of trimethylethylene with methyl iodide and litharge, investigated the interaction of trimethylethylene with methyl chloride in the presence of lime, and obtained a product containing appreciable quantities of 2.3-dimethylbutene and 2.2.3-trimethylbutene (triptene). By recycling the dimethyl compound, further methylation took place, and an enhanced yield of triptene was available. Hydrogenation of the triptene gave the desired triptane. A second route to the same hydrocarbon was discovered by Ipatieff and Haensel[9], who found that, in the presence of metals such as cobalt and nickel and under hydrogen pressure, demethylation of higher *iso*paraffins occurs to yield the next lower homologue and methane. By applying this reaction to 2.2.3-trimethylpentane, one of the *iso*octanes formed by the hydrogenation of butene–*iso*butene codimer, triptane was obtained. Owing to difficulties encountered in separation of the triptane from the original *iso*octane and accompanying *iso*heptanes, the method of Ipatieff and Haensel was less successful than that of Lovell and Miller.

Contemporaneously with the need for *iso*paraffins for aviation fuel, the War also intensified the demand for large quantities of butadiene and styrene for synthetic rubber production. These two compounds were obtained similarly by the catalytic dehydrogenation of butane and ethylbenzene respectively. Considerable difficulties had to be surmounted to obtain the desired products, for paraffin dehydrogenation is

a strongly endothermic, reversible reaction in which comparatively high temperatures (400–700° C.) are necessary to favour dehydrogenation. At these temperatures cracking and, when the paraffins contain more than five carbon atoms in the chain, cyclization, may be marked.

The dehydrogenation of butane on a technical scale[10] was carried out as a two-stage process, the butane being first converted to butenes over a chromium oxide–alumina catalyst at 450 – 490° C., the light gases and butane being separated, and the purified butenes then being further dehydrogenated to butadiene at a somewhat higher temperature in the presence of ten to twenty volumes of high-temperature steam. The addition of steam had the triple advantages of reducing cracking, providing heat for the reaction and removing carbonaceous deposits from the catalyst. Butadiene was separated from butenes and butanes by azeotropic distillation.

Ethylbenzene has been dehydrogenated to styrene under somewhat similar conditions[11] using a chromium oxide – alumina catalyst. The separation of styrene (b.p. 145° C.) from unchanged ethylbenzene (b.p. 136° C.) presented a problem which was complicated by the fact that styrene polymerizes readily at its boiling point under atmospheric pressure. The difficulty was eventually overcome by adding a small quantity of sulphur as a polymerization inhibitor to the feed to the still, working at reduced pressure and dividing the necessary 70-plate fractionating column into two sections.

As already mentioned, under dehydrogenation conditions, hexane and the higher paraffins tend to undergo cyclization to aromatic hydrocarbons. This appears first to have been observed by Moldavski[12], but has also been extensively studied by a number of workers in Great Britain[13] and in the United States. A molybdenum oxide – alumina catalyst is better for cyclizations than a chromium oxide – alumina one.

An interesting offshoot of the work on the production of butadiene by dehydrogenation of butane was the preparation of thiophenes from sulphur and lower paraffins containing four or more carbon atoms in a chain. Thiophenes are now being produced by this means on a considerable scale in the United States[14], and a new field of chemistry is opening up.

It is not possible to deal adequately here with all the new advances in hydrocarbon chemistry, but, in addition to those indicated above, there may be mentioned sulphochlorination and sulphoxidation, telomerization, the 'Oxo' synthesis (see below) and the new acetylene chemistry developed in Germany.

The introduction of a sulphonyl chloride group into paraffins by treatment with chlorine and sulphur dioxide in presence of actinic light was discovered by Reed[15] in the United States. However, the greatest development of the process has probably been in Germany during the War when, on a considerable scale, C_{14}—C_{18} normal paraffins from the Fischer–Tropsch reaction were used to produce alkanesulphonate-type detergents[16]. In a modification of this reaction a paraffin was treated with oxygen and sulphur dioxide in the presence of acetic anhydride during irradiation with ultra-violet light; a peranhydride of acetic and alkanesulphonic acid resulted, and this decomposed in the presence of more paraffin, sulphur dioxide, oxygen and water to yield the sulphonic acid in the ratio of 7–9 molecules for each molecule of peranhydride decomposed[17].

'Telomerization' is the term employed to denote an olefin reaction that has been investigated extensively in the du Pont Laboratories and elsewhere in recent years. Kharasch had shown that, in the presence of peroxides or when irradiated by ultra-violet light, olefins would add on a molecule of a halogenated methane, a halogen going to one end of the double bond, the rest of the methane molecule to the other[17]. When this is carried out under polymerization conditions, the product contains more than one olefin molecule per molecule of non-olefin[18]; the reaction is then a 'telomerization', the non-olefinic adduct a 'telogen' and the reaction product a 'telomer'. Other types of compound such as chloralkane carboxylic acids and their esters, aldehydes, hydrogen halides, etc., also function as telogens. The reaction is of considerable interest in providing a means for building up long-chain compounds with reactive terminal groups.

From a technical aspect one of the most important reactions discovered in recent years is the Roelen reaction or 'Oxo' synthesis, which involves the simultaneous addition of hydrogen and carbon monoxide to an ethylenic bond under certain conditions of temperature and pressure in the presence of cobalt catalysts[19]. Simple olefins yield a mixture of the two isomeric aldehydes to be expected from the addition of the formyl group to either end of the double bond; but structural variations in the olefin influence the proportions of the aldehydes formed, and, in the extreme case when a tertiary carbon atom is at one end of the double bond, the formyl group is added only to the other end. If tertiary carbon atoms occupy both ends of an ethylenic linkage, reaction may still occur if, under the experimental conditions, isomerization to a suitable configuration can take place first[20].

Of outstanding interest theoretically as well as technically is the new field of chemistry that has been opened up by Reppe's work on acetylene reactions[21]. From the many reactions examined, two are of particular interest, namely, the production of acrylic acid from acetylene, carbon monoxide and water in the presence of nickel carbonyl, and of butine-1.4-diol from acetylene and formaldehyde in the presence of copper acetylide. The former reaction opens a new route to polymer-forming materials, the latter to a wide range of organic intermediates including butadiene and tetrahydrofurane.

The polymerization of acetylene to *cyclo*octatetraene in the presence of certain nickel catalysts[22] opens up a new field for investigation by providing a convenient source of this extremely interesting hydrocarbon.

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[2] *J. Amer. Chem. Soc.*, **68**, 1642 (1946).
[3] *J. Amer. Chem. Soc.*, **58**, 913 (1935).
[4] *Indust. Eng. Chem.*, **28**, 418 (1936).
[5] *Indust. Eng. Chem.*, **28**, 1439 (1936).
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[8] Eltekoff, *J. Russ. Phys. Chem. Soc.*, **14**, 382 (1882).
[9] *Indust. Eng. Chem.*, **19**, 853 (1947).
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[14] Rassmussen, Hansford and Sachanan, *Indust. Eng. Chem.*, **38**, 376 (1946).
[15] United States Patent 2,233,676.
[16] B.I.O.S. Final Report No. 478.
[17] *J. Amer. Chem. Soc.*, **69**, 1100 (1947).
[18] British Patent 581,899.
[19] F.I.A.T. Final Report 1000.
[20] Cf. Kaulemanns, Kevante and von Bavel, *Rec. trav. chim.*, **67**, 298 (1948).
[21] B.I.O.S. Final Report No. 266.
[22] B.I.O.S. Final Report No. 137.

OBITUARIES

Prof. John Percival

JOHN PERCIVAL was born at Carperby in Wensleydale on April 3, 1863, and died on January 26, 1949, being survived by his widow and son.

He was educated locally, but later proceeded to Cambridge and graduated from St. John's College in 1888 with honours in Parts I and II of the Natural Science Tripos. Even during his boyhood he was an ardent field naturalist and, while still a student, published a "Flora of Wensleydale" which listed 653 species and varieties, of which all but ten had been seen by himself.

In 1891 he was appointed junior demonstrator in the Chemical Laboratories of the University of Cambridge, and joined that small band of educational pioneers, led by A. D. Hall, who carried agricultural science into the rural areas. During three years he gave numerous courses of "Cambridge University Local Lectures" on botany and chemistry in relation to agriculture, and it was this intimate contact with Surrey and Suffolk farmers and experience in wedding science to agricultural practice that laid the pattern of his life-work.

When the Wye Agricultural College was founded in 1894, Percival was appointed professor of botany and concentrated his attention mainly on hops and cereals. He published several papers on the history, varietal development and diseases of the hop plant which laid the foundations on which E. S. Salmon was to build so brilliantly later. He assembled a living museum of cereals, described in his pamphlet "The Chief Species, Races, and Varieties of European Cereals", this being his first essay in a field which was to become the dominant passion of his life. In 1902 he published a short paper in which the causal relation of *Stereum purpureum* to silver leaf disease was first demonstrated, a problem later developed by F. T. Brooks. In his teaching at Wye, Percival felt acutely the lack of any text-book of his subject, and met this need by his "Agricultural Botany"; in the course of thirty-eight years this ran into eight editions and was translated into many languages. It is easy nowadays to criticize this volume; but, in its day, it was a pioneering effort in a new field, a field itself almost created by Percival, and the several editions have largely shaped the development of the subject in university and college teaching.

In 1902, Percival was appointed director of the Agricultural Department in what was then the University College, Reading, and in 1907 became professor of agriculture. For ten years he had to cover the whole field of agriculture, and his publications ranged over such diverse topics as weeds, mountain pines, manures and manuring, and the "Soils of Dorset"; in 1907 he was one of the presidents of the Second National Conference of the Poultry Industry. In 1910 he published his researches on "Potato 'Wart' Disease", which gave the disease and the pathogen their modern names and laid the foundations of our knowledge of this problem. During this period he was also assembling and making an intensive study of the world's wheats, and building up in Reading a centre of agricultural education and research. In 1910 he published his "Agricultural Bacteriology", again a pioneering effort in a new and rapidly developing field which the book largely patterned.

In 1912 a chair of agricultural botany was established in the College and Percival became the first professor, holding this appointment until his retirement in 1932: in 1926 the College had become the University of Reading. Percival was at last able to devote all his energies to his wheats. Earlier he had founded an Agricultural Botanic Garden containing a living museum of wheats, and he developed this until it comprised many thousands of named species, varieties and races of *Aegilops* and *Triticum* collected from all over the world. In 1921 this work came to splendid fruition in his monumental treatise, "The Wheat Plant", which at once gave him recognition as the foremost world authority: among his correspondence are letters from Vavilov and other specialists containing glowing tributes to "this classic work".

During the next ten years Percival devoted his attention to the cytological analysis of *Aegilops* × *Triticum* hybrids, on which he published several papers, and began the preparation of his book on "Wheat in Great Britain" which was published in 1934, and appeared in a second edition a few months before his death. During his last years he was actively engaged in research on seed germination and seedling growth. In his old Department at Reading there remain his fine herbarium of British plants, his remarkable collection of seeds, a complete set of dried specimens of his wheats with his annotations, and the living museum of wheats and the Agricultural Botanic Garden which he founded.

John Percival was no ordinary man. His force of character, tireless enthusiasm and immense physical and mental energies enabled him to achieve a vast amount of enduring work. He was an accomplished linguist, a musician and artist of merit, an expert photographer, a scholar, and a lover of books, of which he possessed an astonishingly wide and intimate knowledge. He was an inspired teacher with an encyclopædic knowledge of agriculture and botany on which he could draw at will. He was equally at home with both student and farmer; but there was always about him a certain brusqueness and an aloofness from the common world which made him impatient of trivialities; nor did he suffer fools gladly. He was a splendid field naturalist, loving wild things and wild and lonely places, and it was this passion that, in his earlier years, took him to remote Scandinavia to dwell for months among the Lapps, and later compelled him to the Alps and the Pyrenees, to the Welsh mountains, and ever and again to his own beloved Yorkshire dales.

John Percival was an eminent scientist who, perhaps, received more recognition in other countries than in his own, and in his passing, agricultural science has lost a memorable figure.

WILLIAM B. BRIERLEY

Dr. M. C. Rayner

BY the sudden death of Dr. M. C. Rayner, on December 17, British mycology has sustained a serious loss. Up to the last moment she had been pursuing her researches into the mycorrhizal habit in plants, and, in fact, died only a few hours after visiting her experimental plots at Wareham Heath in Dorset. Relatively early in her career, Dr. Rayner had established herself as unquestionably the leading British authority on the subject of mycotrophy in plants—a position which she afterwards consolidated both by the volume of her own research, and by the breadth of her interests in her chosen field of work.

Dr. Rayner's interest in the mycorrhizal habit, and her scientific collaboration with Prof. W. Neilson Jones, to whom she was married in 1912, both started in 1910 with an inquiry into the ecology of *Calluna vulgaris* on the Wiltshire and Berkshire Downs. This investigation led a few years later to the publication of a now classical paper for which she was awarded the degree of D.Sc. by the University of London, on "Obligate Symbiosis in *Calluna vulgaris*". In this paper she established in great detail the nature and extent of the association between *C. vulgaris* and its fungus endophyte, *Phoma radicis callunæ*. Numerous other papers on the endophytic mycorrhiza of heath plants followed, and in 1927 she published her monograph on "Mycorrhiza", as a *New Phytologist* reprint; more than twenty years later, this monograph is still an invaluable work of reference, as well as a pleasure to read.

As a result of a discussion in Bagley Wood, Oxford, on the occasion of the British Association meeting in 1926, Dr. Rayner started work on the other large group of mycorrhizal fungi, the ectophyte associates of forest tree roots. This led both to some most interesting fundamental work on the nature of ectophytic mycorrhiza, and to the solution of an important practical problem—the establishment of young conifers on the Wareham Heath area of Dorset, a difficulty that had for some time vexed the Forestry Commission. Later the Commission provided Dr. Rayner with a research nursery and a scientific helper to assist her investigations at Wareham and elsewhere. Dr. Rayner's series of papers on these tree investigations, together with other contributions by herself and Prof. Neilson Jones, were reprinted in 1944 by Messrs. Faber and Faber in a single volume under the title "Problems in Tree Nutrition"—an indication of the wide interest aroused by this work. In recent reports, Dr. Rayner has stressed the importance not only of the compost but also of the system of cultivation used in conjunction with it, for the promotion of maximum fungal activity and for the maintenance of soil fertility in the forest nurseries. Dr. Rayner's precise interpretation of her results on the Wareham Heath plots is still a subject for controversy and further experiment; none would deny, however, that by her striking demonstration of the value of organic composts for the establishment of coniferous seedlings she has been an outstanding benefactor to forestry.

At times, Dr. Rayner was wont to deplore the controversy, not infrequently bitter, that has always ranged around the subject of mycorrhiza, and in which, during her life, she was well to the forefront. Partly as a result of her own work, however, the benefit to the host of the ectophytic mycorrhizal association is now established almost beyond question, even though its mechanism still requires further elucidation. The benefit derived from the endophytic mycorrhizal habit, by heath plants, orchids and others, on which Dr. Rayner insisted so strenuously, has always been harder to prove; for a long time, the crucial experiment always seemed to be just beyond the grasp of investigators, but recent work suggests that the fungus endophyte may bring about the successful establishment of its seedling host by supplying missing growth factors, as well as by rendering biochemical assistance in other ways, perhaps.

In recent years, Dr. Rayner extended her interests to embrace mycorrhizal associations in a great variety of crops, tropical as well as temperate, and travelled widely in pursuit of her work. To those who knew her well she could be a delightful and stimulating companion, whether in the laboratory or the field, and a visit to her laboratory at Bedford College always gave one plenty to think about. Her long scientific collaboration with her husband, Prof. Neilson Jones, in which temperaments and interests were most happily blended, was a very fruitful one; right up to the last, she had refused to give in to chronic ill-health, and her determination to continue with her work at all costs gained the admiration of all who knew her.

S. D. GARRETT

Mr. G. E. F. Fertel

GEOFFREY FERTEL was born on November 19, 1913, at Bromley, Kent, where his father, who was of Huguenot ancestry, was well known for his musical ability and was organist at the parish church; his maternal grandfather, Benjamin Harrison, was distinguished as an archæologist. While still a small child, he showed unusual interest in natural things and in mechanisms; his love of the countryside was encouraged by his Kentish environment, and at Sevenoaks School he was allowed to spend time on botany instead of games, for which he had no liking.

On entering the Imperial College of Science and Technology, London, Fertel decided to study physics, and was soon recognized as a quick and ingenious constructor and experimenter. Though an indefatigable inquisitor of his teachers, Fertel was never happy until he had 'seen through' a mechanism or a problem in his own way, which usually involved an analogy with some other mechanism or problem, often in another branch of science. He had little interest in formal science, and less in formal people.

After graduation, he remained at the College as a research student, taking part in developing the new technique of time-of-flight measurements with slow neutrons. He left not long before the outbreak of war to join the physics staff of the University of Bristol; but there was already no doubt that his great ability to make apparatus work was matched by a power to see clearly the right technical method to apply to any particular scientific problem. At this time, too, his devotion to scientific things began to leave room for personal friendships that grew in number and strength as time went on. He became noted for original demonstration experiments and for technical jokes such as the perfectly constructed left-handed wood-screw kept in his pocket to hand to a colleague in need, with a right-handed one in the other pocket to be offered as soon as the joke had been enjoyed.

During the War, Fertel worked in the Admiralty Signals Establishment, where his talent for understanding and making things yielded several devices, of which at least one is still an essential part of Service radar equipment. He was glad to return to university life at Bristol and took part in many activities, not only in the laboratory but also in such pursuits as the exploration of caves, both in England and on the Continent. He left Bristol in 1948 to join in the construction and operation of the large cyclotron at the University of Birmingham, and quickly gained the admiration and the affection of his new colleagues. On January 19, 1949, while making adjustments to the cyclotron, he was electrocuted and died instantly.

Fertel left little published work, but will long be remembered as a man of extraordinary energy and skill whose passion was to know and to understand.

NEWS and VIEWS

Botany at Delhi : Prof. P. Maheshwari

Dr. Panchanan Maheshwari, who is well known for his work on angiosperm embryology and cytogenetics, has been appointed to a chair of botany in the University of Delhi. Receiving his early training at Allahabad, he came under the influence of an American botanist, the late Dr. Winfield Dudgeon, and in 1931 was the first to obtain the degree of D.Sc. in botany in the University of Allahabad. As a teacher he served successively as a lecturer and associate professor of botany at Agra College (1930–37). For about two years (1937–39) he was lecturer in the University of Allahabad and for a brief term in Lucknow, later migrating to Dacca as reader in botany and head of the department, where he developed facilities for postgraduate teaching and research. He was recently promoted professor of botany in the University of Dacca and became dean of the Faculty of Science.

Prof. Maheshwari has travelled widely for the sake of developing contacts with colleagues in his own field of research, undertaking two long study tours in Europe (1936–37) and in the United States (1945–47). His original work has been largely influenced by the school of Tischler at Kiel and of Schnarf in Vienna. He has done much, both directly and indirectly, to advance the study of angiosperm embryology in India. He is the author of an advanced text-book on the "Embryology of Angiosperms", which is shortly to be published, and is editing for the *Chronica Botanica* series a "Manual of Angiosperm Embryology" based upon contributions from specialists in many countries of the world. He is president elect of the Section of Botany at the next Indian Science Congress to be held in Poona in January 1950.

Nature Conservancy in Britain

Mr. Herbert Morrison announced in the House of Commons on February 11 that arrangements have been completed for forming a Nature Conservancy, and that a separate committee will supervise activities in Scotland. Membership of the Conservancy will be as follows : Prof. A. G. Tansley (chairman) ; Mr. A. Anderson, M.P. ; Mr. C. Elton ; Dr. E. B. Ford ; Dr. H. Godwin ; Mr. E. H. Keeling, M.P. ; Mr. N. B. Kinnear ; Prof. R. C. McLean ; Prof. J. R. Matthews ; Mr. E. M. Nicholson ; Prof. W. H. Pearsall ; Mr. M. Phillips Price, M.P. ; Mr. J. A. Steers ; Mr. W. L. Taylor ; and Dr. A. E. Trueman. The Conservancy—Mr. Morrison referred to the term as a more convenient title than conservation board—will be responsible for the whole of Great Britain ; but as a result of the recommendations of the Scottish Wild Life Conservation Committee, and of consultations with the Secretary of State, activities in Scotland will be supervised by a Scottish committee with the following composition : Prof. J. R. Matthews (chairman) ; Mr. A. Anderson, M.P. ; Mr. H. C. Beresford-Peirse ; Dr. F. Fraser Darling ; Mr. A. B. Duncan ; Dr. D. N. McArthur ; Sir Basil H. H. Neven-Spence, M.P. ; Prof. A. D. Peacock ; Prof. J. Ritchie ; Prof. J. Walton ; Lord Wemyss and March ; and Prof. C. M. Yonge.

Dr. John Berry, who is known for his work in fishery research and for contributions on wild life in Britain, and in 1944 was appointed biologist to the North of Scotland Hydro-Electric Board, has been released to serve as director for Scotland of the Conservancy. It has already been announced that Captain Cyril Diver has been appointed as director-general, with his office at Thorney House, Smith Square, S.W.1. The Conservancy is seeking a charter on similar lines to that of the Agricultural Research Council, with which it will co-operate. The Committee of the Privy Council for Agricultural Research will be reconstituted as the Committee of the Privy Council for Agricultural Research and Nature Conservation, and the Minister of Town and Country Planning will join it in view of its extended responsibilities. The Conservancy will start work at once.

Institution of Mechanical Engineers : James Clayton Prize

The Council of the Institution of Mechanical Engineers has awarded the 1948 James Clayton Prize of £1,350 to Mr. Karl Baumann, for his contributions to the advancement of mechanical engineering science by way of invention, design and investigation, communicated, in part, in a lecture delivered to the Institution in 1948. Mr. K. Baumann is the chief mechanical engineer and a director of the Metropolitan-Vickers Electrical Co., Ltd., Manchester. His professional life has been largely identified with the development of the modern steam power station including steam turbines and boiler plant, and latterly the internal combustion turbine. He received the Institution's premier award, the Thomas Hawksley Gold Medal, for a paper published in 1930. The James Clayton Bequest is for the distribution annually, on research, investigation and the encouragement of mechanical engineering science, of three-quarters of the income of the fund. The remaining quarter of the income is for the award (James Clayton Prize) to a member, associate member, graduate or student of the Institution, who contributes most in the year to modern mechanical engineering science. Previous awards have been made to Sir Frank Whittle (1945), Mr. Hayne Constant (1946), Sir Richard Southwell (1946), Mr. T. E. Beacham (1947), and Mr. J. E. Sears (1947).

Midwest Research Institute

Dr. George E. Ziegler has been appointed director and Dr. Clayton O. Dohrenwend assistant director of the Midwest Research Institute, Kansas City. Dr. Ziegler went to the Institute at the time of its inception in 1945 as executive scientist, having previously been associated with the Armour Research Foundation in Chicago. He is known in scientific circles for his experimental X-ray diffraction studies, and has been acting chief administrator of the Institute since the resignation of Harold Vagtborg some six months ago. Dr. Dohrenwend has been research consultant since going to the Institute in July 1946. He was formerly associated with the Illinois Institute of Technology as director of the Mechanics Department. He is a specialist in the field of engineering mechanics and past president of the Society for Experimental Stress Analysis.

East African Industrial Research Board

The fifth annual report of the East African Industrial Research Board (Pp. iii+28. Nairobi, P.O. Box 1587. 1*s.* 6*d.*), covering the year ended December 31, 1947, includes the report of the acting chairman, Mr. H. B. Stent, the General Laboratory report, the annual report of the Tanganyika Industrial Committee,

1947, and a list of publications on industrial research in East Africa. A departmental report on ceramics details the work carried out on bricks and roofing tiles, domestic pottery, refractories, building materials, glazed wall-tiles and drain-pipes, while a fairly full account is given of work on the extraction of undried pyrethrum flowers, which has given results comparing favourably with existing methods of extracting dried flowers and appears to merit large-scale trials. Work on silicophosphate is also described in detail, including the results of rotary kiln firings, laboratory-scale firings, and of investigations on the fractions of the clinker soluble in water and in citric acid. Investigations on the treatment of effluents from the processing of sisal and coffee have continued, and biological filtration gave promising results for the former. The Tanganyika Industrial Committee reports on the production of totaquina, the final target of 10,000 lb. for which was met early in November, 1947. Other investigations under the Committee related to the assay and manufacture of papain, and the assay and cultivation of pyrethrum flowers. The Board itself at its three meetings during the year focused its attention on negotiations for the early establishment of a permanent East African Scientific and Industrial Research Organisation, and a memorandum was submitted to the East African Governments and to the Colonial Office advocating the establishment of such an Organisation on the lines of other existing inter-territorial research organisations. Stress was laid on the vital need of such work if the large sums of money for the development of the East African territories are to be used to the best advantage.

Parliamentary and Scientific Committee

THE annual report for 1948 of the Parliamentary and Scientific Committee records the visit of a deputation from the Committee to discuss with the Minister of Education the position in Britain of colleges of technology. The Minister said that the report of the Committee agreed closely with the policy of the Ministry; but he thought that a National Council of Technology would be too cumbersome. He agreed that the status of technical colleges should be raised, and promised to increase the number of technical State Scholarships immediately the demand and capacity to take advantage of such scholarships existed. Members of the Committee took a very active part in debates on the Development of Inventions Bill, and a critical discussion of the Bill was arranged on May 11. Early in the year a detailed memorandum on current difficulties in the import of scientific books and periodicals was submitted to the Board of Trade, and information collected from scientific bodies about the shortage of paper and facilities for producing scientific books and periodicals was incorporated in a memorandum forwarded to the Lord President of the Council in July. A reply from the Lord President in September stated that the paper allocation for the production of books was practically equal to that used in 1939 and that about double the number of books were being produced. A further memorandum, which, among other recommendations, urged that the criteria to be applied should be whether the output was meeting the greatly increased requirements in Great Britain and overseas for up-to-date scientific and technical information, and not pre-war figures, was submitted to the Lord President in November. A memorandum on steel utilization has also been prepared by the Committee; technical education, the salaries of teaching and research staff in medical schools and universities, and the Veterinary Surgeons Bill have also been considered.

Superconducting Bolometers

DURING the past few years a sensitive form of bolometer has been developed, at the Johns Hopkins Cryogenic Laboratory, under the direction of Dr. D. H. Andrewes, which makes use of the high variation of electrical resistance with temperature that occurs in the region between the normal- and zero-resistance states of a superconducting material. Tantalum (*Rev. Sci. Instr.*, 13, 281; 1942) has been used successfully, but it requires to be cooled to liquid helium temperatures. Columbium nitride, with a transition temperature at about 15° K., just above the triple point of hydrogen, presents a much less difficult temperature-control problem, and bolometers of very high sensitivity have been made. These should prove useful for the examination of the as yet unexplored region of emission spectra of sources at room temperature, with considerable application in biological research. Recently, a careful study of the infra-red sensitivity of a number of columbium nitride superconducting bolometers has been made by N. Fuson (*J. Opt. Soc. Amer.*, 38, 845; 1948), and the sensitivities have been compared with those of other infra-red detectors. Details of the construction of the bolometers, of the infra-red source, modulator, cryostat, wide-band amplifier, and other auxiliary equipment, together with the experimental procedure, are given. Time constants of 0·7 to 17·0 milliseconds were observed. For the purposes of comparison, a factor of merit, based on the reference conditions suggested by R. C. Jones (*J. Opt. Soc. Amer.*, 37, 888; 1947) and R. Havens (*J. Opt. Soc. Amer.*, 36, 355 A; 1946), is defined. The nine most sensitive of the twenty-five superconducting bolometers examined had factors of merit between 1·3 and 14·0.

Functional Embryology

THE New York Academy of Sciences has issued a publication entitled "Recent Studies in the Mechanisms of Embryonic Development" (*Ann. New York Acad. Sci.*, **49**; 1948) the title of which is self-explanatory. It contains nine contributions by separate authors each dealing with one aspect of the general subject, and each article is well illustrated and provided with a brief summary of the relevant work and a bibliography. The subjects dealt with include: the early organisation and differentiation of prospective areas in the developing eggs of *Nereis*, the amphibians *Triton* and *Ambystoma*, and the chick; biochemical differentiation; the role of nerves in amphibian limb regeneration; and locomotor responses and retinal development in normal and transplanted retinæ. Incidentally the name '*Amblystoma*' is used in two of the papers instead of the correct form *Ambystoma*. It is difficult to pick out for special notice any one paper; but that by S. R. Detwiler on "Quantitative Studies on Locomotor Responses in Amblystoma Larvæ following Surgical Alterations in the Nervous System" with its reconstructions is of particular interest in view of the recently published book by C. Judson Herrick on the brain of *Ambystoma*.

National Tsing Hua University: Science Reports

THE three series of the *Science Reports of the National Tsing Hua University* (Series A: mathematics, physics and engineering; Series B: biology

and psychology; Series C: geology, geography and meteorology), published for several years before 1937, were suspended during 1937–45, with the exception of one issue of Series A printed in September 1940. With the return of the University to Peiping, publication of the three series has been resumed, and, so far, two issues of Series A (**4**, Nos. 4, 5 and 6; 1947, and **5**, No. 1; 1948) have been received. The papers appearing in the 1947 issue were originally intended for publication in 1941 to commemorate the thirtieth anniversary of the University (1911–41); but, although the University was then at its wartime home at Kunming, the *Reports* were being printed in Shanghai, which was overrun by the Japanese military forces, and therefore they could not be published. The *Reports*, which are in English or French, indicate clearly how, in spite of extremely trying conditions, research work of a high standard continued to be carried out in the University.

Melbourne Seismological Station

THE Council of the University of Melbourne recently approved an arrangement whereby the seismograph of the former Melbourne Observatory, which the University accepted from the Government of Victoria when the Observatory was disbanded in 1941, will in future be in the care of the Department of Geology of the University. A member of staff of the Geology School (Mr. A. J. Gaskin) has been nominated seismologist, and a technical assistant provided for him. It is hoped that the issuing of seismological bulletins will be commenced in June 1949, and that the issue will thereafter be at regular intervals, probably quarterly. Instrumentation remains unchanged for the present. All records later than those listed in the last leaflet issued for the Observatory (July 2, 1940) have been inspected, and information regarding them may be obtained on application. Correspondence (including requests for the receipt of bulletins) should now be addressed to the Seismologist, Department of Geology, University of Melbourne, Carlton, N.3, Victoria, Australia.

Sir D'Arcy Thompson: Commemoration Fund

SOME of the many friends and pupils of the late Sir D'Arcy Thompson have issued an appeal for contributions to a commemoration fund which will be used for the following purposes: (1) presentation of a bronze head to the University of St. Andrews; (2) presentation of a portrait in oils to University College, Dundee; (3) memorial prizes in the Departments of Natural History at St. Andrews and Dundee. The printed announcement of the fund contains excellent reproductions of the portrait and of the clay model of the head. It has not been possible to communicate personally with all of Sir D'Arcy Thompson's friends, but copies of the announcement may be obtained from the Secretary of the Fund, D. R. R. Burt, Department of Natural History, the University of St. Andrews.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been announced: D. Leuchars, assistant conservator of forests, Uganda; E. Q. O'B. Smith, assistant conservator of forests, Northern Rhodesia; D. A. Aitkenhead, geologist, Gold Coast; C. Facer, surveyor, Uganda; K. T. Pugh, surveyor, Tanganyika; A. H. Ward, surveyor, Northern Rhodesia; S. E. Brinkman, meteorological assistant, East African High Commission; F. J. Cornish, meteorological assistant, East African High Commission; A. P. Johnson, assistant meteorologist, Nigeria; E. B. Powell, assistant controller (radio), Federation of Malaya; C. J. M. Simpson, entomologist, East African High Commission; S. D. Ross (principal agricultural officer, Nigeria), assistant director of agriculture, Nigeria; F. W. Roe (geologist, Federation of Malaya), chief geologist, Borneo; H. R. Binns (deputy director of veterinary services, Palestine), scientific officer, East African Veterinary Research Organisation; R. M. Gambles (veterinary officer, Cyprus), senior veterinary research officer, Nigeria; R. E. Gould (senior poultry and bee-keeping officer, Palestine), fisheries officer, Tanganyika; W. D. Silvera (medical officer, Jamaica), senior lecturer in pathology, University College, Ibadan, Nigeria.

Announcements

THE following appointments have been made in the University of London: Mr. F. Wormald, to the University chair of palæography tenable at King's College as from January 1, 1950. Dr. G. L. Brown, of the National Institute for Medical Research, to the Jodrell chair of physiology tenable at University College as from October 1, 1949. The title of professor of logic and scientific method in the University has been conferred on Dr. K. R. Popper in respect of the post held by him at the London School of Economics.

THE Brewster Gold Medal of the American Ornithologists' Union has been awarded to David Lack, director of the Edward Grey Institute of Field Ornithology at Oxford, for his book "Darwin's Finches", published in 1947 by the Cambridge University Press. The Medal is awarded for the most important work relating to the birds of the western hemisphere published during the preceding six years.

IN co-operation with the University of Edinburgh and the East of Scotland College of Agriculture, the Association of Agriculture is arranging a Conference, intended primarily for teachers, on "Applied Biology, Geography and Education" at the College of Agriculture, 13 George Square, Edinburgh, during April 12–14, 1949. The registration fee is 2*s.* 6*d.*, which includes the inaugural dinner, and tickets and further details may be had on application to Alexander Hay, General Secretary, Association of Agriculture, 238–240 Abbey House, 2 Victoria Street, London, S.W.1.

APPLICATIONS are invited for Lady Tata Memorial Fund grants and scholarships to scientific workers of any nationality for research in diseases of the blood, with special reference to leukæmia, in the year beginning October 1, 1949. Grants are made for research expenses, and scholarships are awarded as personal remuneration, their normal value being £400 per annum for whole-time research, or less for part-time work. Applications must be submitted before March 31, 1949, and the awards will be announced in June. Further particulars and forms of application may be obtained from the Secretary of the Scientific Advisory Committee, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

ERRATUM.—Referring to his communication entitled "*Trypanosoma heptatretæ* sp.n., a Blood Parasite of the Hagfish" (*Nature*, 161, 440; 1948), Mr. Marshall Laird has written proposing amending the name to *T. heptatreti* in accordance with the International Rules of Zoological Nomenclature.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

An Electron Microscope Study of the Nuclear Membrane

THE giant nuclei of full-grown oocytes of Amphibia offer unique opportunities for anatomical and physiological study, on account of the relative ease with which they may be isolated and handled. The material for the present study was obtained from *Triturus cristatus* and *Xenopus lævis*.

Under a low-power binocular, the nuclei are isolated into distilled water with the aid of needle and forceps. In this medium the nucleus rapidly swells, and meanwhile adhering cytoplasmic materials may be pumped away by means of a pipette. The entire nucleus, freed from cytoplasm, is then transferred to fresh distilled water: a copper specimen grid is now placed in the same container, and the nuclear membrane ruptured and stretched out over the grid by means of a pair of fine-pointed tungsten needles. After the stretched membranes have been pumped free from nuclear sap, they may be dried directly or after prior fixation. For the preservation of fine structure, fixation appears to be necessary.

Grids carrying nuclear membranes were examined in a Siemen's electron microscope operating at 52 kV., the magnification of the photographic negative being 12,000–15,000 diameters. The photographs, three of which accompany the present letter, indicate that the nuclear membrane is a compound structure. One component is a porous sheet, the pores being approximately 300 A. in diameter in hexagonal array, with a repetition distance of about 800 A. It must be borne in mind, however, that the membranes are readily distorted during preparation, the hexagonal arrangements being frequently disturbed. The other component is a membrane with no evident fine structure. This closely over- or underlies the porous membrane; but the relative positions of the two are not yet known. Under certain as yet ill-defined conditions, the porous membrane disintegrates in the process of specimen preparation, leaving the structureless membrane only.

It may be presumed that the structureless component determines the permeability properties of the nuclear membrane. Other investigations have shown that egg albumen cannot penetrate this membrane, and hence even if a porous structure is present it would be beyond the limits of resolution of the existing microscope. The visibly porous membrane, on the other hand, probably acts merely as a mechanical support for the structureless membrane.

This work is being continued, and a detailed account will be published elsewhere.

H. G. CALLAN

Institute of Animal Genetics,
Edinburgh.

J. T. RANDALL
S. G. TOMLIN

Wheatstone Physics Laboratory,
King's College,
Strand, London, W.C.2.
Nov. 12.

X-Ray Diffraction Study of the Structure of Bacterial Flagella

FOLLOWING on the demonstration by Gard[1] of the practicability of obtaining the flagella from bacterial cultures in fair yields and in a highly purified state more detailed chemical and physicochemical investigations are now being undertaken under a scheme supported by the Swedish Natural Science Research Council. Data have already been published by Weibull and Tiselius[2] on the flagellar material prepared by Gard from *Salmonella paratyphi* B., and by Weibull[3] on the flagella of the harmless and easily cultivated *Proteus vulgaris*. The present communication is a preliminary account of an X-ray diffraction study of flagellar material prepared at Uppsala and brought to Leeds.

We have so far examined the flagella of *Proteus vulgaris* and *B. subtilis*. The method of preparation was as already described[3]; here we need only say that the final product from *Proteus*, for example, forms a colourless stable viscous solution with strong flow birefringence. It gives a precipitation reaction with a *Proteus* × 19 *H* rabbit antiserum, has a nitrogen content of 15·7–16·1 per cent, shows only traces of phosphorus and 1 per cent carbohydrate at the most, and contains no tryptophane and no purine or pyrimidine bases: it has the characteristics of a protein but not of a nucleoprotein. When examined in the electron microscope, essentially only one structural element is seen—long flexible threads of the same thickness as the flagella on the bacterium, but shorter, presumably owing to breakage during the purification process.

The flagella are also reversibly precipitable with ammonium sulphate and show electrophoretic mobility; in brief, they behave like long macromolecules and therefore invite X-ray study by just those tech-

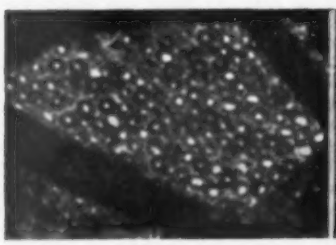

Fig. 1

Fig. 1. *Triturus cristatus*. The porous sheet component of the nuclear membrane after fixation with osmium tetroxide. Magnification 34,000 diameters

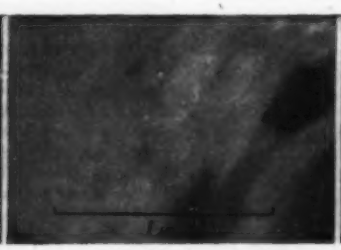

Fig. 2

Fig. 2. *Triturus cristatus*. The structureless sheet component of the nuclear membrane after fixation with osmium tetroxide. Magnification 34,000 diameters

Fig. 3

Fig. 3. *Xenopus lævis*. Portion of nuclear membrane fixed with phosphotungstic acid. Magnification 27,000 diameters

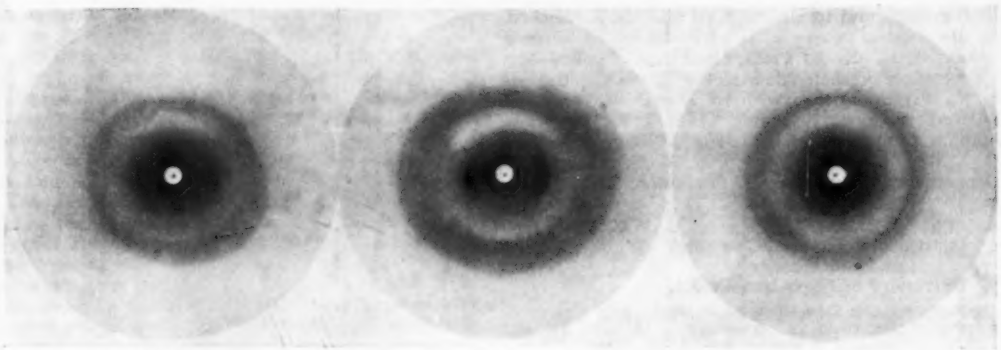

Fig. 1 Fig. 2 Fig. 3

Fig. 1. X-Ray fibre diagram given by thin film of flagella of *Proteus vulgaris* photographed with the beam parallel to the plane of the film. (Plane of film parallel to long edge of page)

Fig. 2. Same as Fig. 1, but for *B. subtilis*

Fig. 3. Partial β-diagram obtained after squeezing moist film of *Proteus* flagella between pieces of plate glass

niques that we have evolved for myosin, sodium thymonucleate, and many other similar preparations. In these preliminary experiments we have simply made very thin films by allowing small pools of the viscous solution to dry on microscope slides previously treated with dichloro-dimethyl-silane to make them water-repellent. The films were then easily detached, and specimens suitable for X-ray examination were built up from several strips lying flat on top of one another. It should be emphasized that the drying process causes no significant deterioration: the films could be redissolved in water and the solution still showed flow birefringence.

When the solution is dried to a thin film the flagella are brought to lie approximately in one plane, and a pseudo-fibre diagram should be obtained when the X-ray beam is parallel to this plane. Figs. 1 and 2 illustrate two of the photographs we have obtained in this way. Detailed analysis will be given later (in any case the experiments are still proceeding with the view of getting better orientation and higher resolution), but already it may be stated that the diagrams conform in the main to the α-type characteristic of the great family of elastic fibrous proteins that we have called the keratin–myosin–epidermis–fibrinogen group[4]. Not only is the now well-known meridional reflexion at about 5·1 A. clearly in evidence, but also there are at least half a dozen other reflexions that find their counterparts in hair and muscle photographs and particularly in MacArthur's high-resolution diagram of porcupine quill[5]. In addition, we have succeeded in stretching *Proteus* flagella into the β-form—not as yet by direct pulling, to be sure, but by squeezing moist film at room temperature between pieces of plate glass, after the procedure found effective with myosin[3], for example. In our experiments so far, the resulting squeezed film was too fragile to mount intact for the purpose of taking an X-ray photograph with the beam parallel to the surface, and we have had to be content with a powder photograph (Fig. 3); but there is no doubt that the diagram reveals appreciable transformation into protein of the β-type; it is, in fact, very like what is found after heating the flagella to about 100° (cf. myosin again).

It follows that, from the X-ray point of view at least, the flagella on *Proteus* and *B. subtilis* are of the nature of primitive hairs or muscles—and it is not of basic importance which name is used, since X-ray and related studies indicate that the whole of the keratin–myosin–epidermis–fibrinogen group is derived from a single master plan[4]. From electron micrographs taken at Leeds of *Proteus* flagella and tobacco mosaic virus in the same field, it is seen that the former (when dry) are definitely the thinner of the two; their thickness is about four-fifths or five-sixths that of the virus particles (150 A.)—say, roughly, 120 A. Conceivably, therefore, these flagella may even be described as 'monomolecular' hairs or muscles, for their thickness falls within the order of size of the largest side-spacings[6,7,8] that have been observed or inferred for other members of the keratin–myosin–epidermis–fibrinogen group; and besides, there is a rather surprising detail and sharpness about the photographs which suggests a structural simplification as compared with hair keratin, for example. There are reasons for thinking that the latter is a polyphase system built of polypeptide grids (or combinations of grids) of similar form but varying amino-acid constitution[5,9]; but it may be that the framework of a flagellum is constructed from only one such type of component.

At all events, it is clear that a most promising new field is opened up, with a new approach to the mechanics of protein structures and probably fresh light on the problem of the muscle machine. We are strengthened in this last suggestion by the curious fact that though the normal flagella diffraction diagram, as stated above, is composed mainly of reflexions conforming to the α-form of the keratin–myosin–epidermis–fibrinogen group, what appears to be the characteristic backbone reflexion of the β-form is also present, and indeed not in its usual position on the equator, *but on the meridian*. Such a transposition was observed some years ago by Rudall[10] in supercontracted preparations of epidermis, myosin, fibrinogen and fibrin, and he interpreted it as direct experimental evidence in support of the suggestion[4] that the α-form may shorten simply by developing longer transverse folds. If Rudall's interpretation is correct—and there is a great deal to be said for it—then it is tempting to suppose that the flagella diffraction diagram reveals also a partial state of contraction.

We should like to express our indebtedness to Mr. E. Beighton for his skilful aid in taking the X-ray

photographs, and to Dr. R. Reed and Mr. A. Millard for the electron micrographs of *Proteus* plus tobacco mosaic virus, also to Profs. Gard and Tiselius our appreciation of their encouraging interest. One of us (C. W.) would also wish to thank the Swedish Natural Science Research Council for a grant enabling him to take part in the investigation.

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Sectioning of the Bacterial Cell for the Electron Microscope

The introduction of a technique for cutting ultra-thin sections of biological tissue with the conventional microtome[1] has also made feasible the sectioning of isolated cells for the electron microscope. Bacterial cells were chosen as a first example because of convenient size, ease of handling in large numbers, and because of the intrinsic importance of any new approach to the problems of bacterial morphology.

B. megatherium was grown on nutrient agar, and when the culture was approximately twenty-four hours old, quantities of cells were transferred with a wire loop to a 5 per cent formalin solution in a centrifuge tube. After one hour of fixation the cells were centrifuged for five minutes at 20,000 r.p.m. and the formalin then poured off. Dehydration with a graded series of alcohols was then carried out, using the centrifuge to keep the bacteria together in the transition from one solution to another. Impregnation with Mallinckrodt 'Parlodion' followed, starting with 3 per cent 'Parlodion' in equal parts of ether-alcohol and ending in a 12 per cent solution. Transition from 6 to 12 per cent 'Parlodion' was accomplished by evaporation of the solvent. After one day in 12 per cent 'Parlodion', chloroform was used as a hardening agent, after which the hardened block was broken out of the centrifuge tube. Impregnation of the block with paraffin (m.p. 65°) followed, after going through a carbol-xylol bath to remove the last traces of water. The doubly embedded block was finally mounted on a plastic pillar which could be clamped in the microtome.

One-tenth micron sections were cut as described in ref. 1, and were flattened on a microscope slide, using needles under a binocular dissecting microscope. The paraffin was removed with benzol, after which the slide was dipped vertically into a beaker of dilute (0·2 per cent) collodion in amyl acetate. This replaced the original collodion with a thinner and more homogeneous film, which was then floated off on a clean water surface. Microscope specimen screens (200 mesh) were placed on the sections and the entire film inverted and mounted on another slide. After drying, the specimens were ready for examination in the electron microscope.

Transverse and longitudinal sections of *B. megatherium* approximately 0·1 microns thick. × 25,000; 50 kV. Note similar density and detail in the two cells

Since the cells were oriented at random in the block, the sections might be expected to show cells cut at various angles. The accompanying photograph shows two cells which were nearly at right angles in the block, giving rise to a longitudinal and a transverse cut in the same field of view. Sufficient internal detail is visible in both cells to make it clear that the sections are adequately thin for effective use with a 50-kV. electron microscope. Much further work will, of course, be necessary to establish the significance of the internal detail observed in an experiment of this type. It is the purpose of this note merely to describe a new technique, which may profitably be used in the study of bacterial morphology and the relationships of bacteria and bacterial viruses.

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A Method of Sectioning Bacteria *in situ* for Electron-microscopical and Cytochemical Investigations

A method has been developed for preparing sections of bacterial cells for observation with the electron microscope. An impression preparation of a young growing culture is made on a polished glass surface and fixed with osmic acid. On to this a beryllium film is evaporated by means of Hast's method[1]. The beryllium film is then stripped from the glass surface and frequently carries with it a section through the bacterial cells with their relationships undisturbed. During the evaporation of the

beryllium, some atoms of the metal penetrate the surface of the cells, thus anchoring a layer of the bacterial cytoplasm to the film. This layer is normally removed when the film is stripped, although sometimes whole cells adhere to the film as shown in Fig. 1. The process can be repeated and a further section of the same group of cells obtained. Fig. 2 shows such a section from a young and rapidly dividing culture of Enterococci (*Str. fæcalis*). The cell appears to contain a round, well-defined body which seems to divide at the same time as the cell. It is further possible to treat the sectioned bacteria with agents (such as enzymes or antibodies) and to re-examine the sections on the beryllium film. The section can be washed with buffers and digested with enzyme preparations. It should thus be possible to combine this technique with cytochemical investigation. The result of such studies will be described in a further communication.

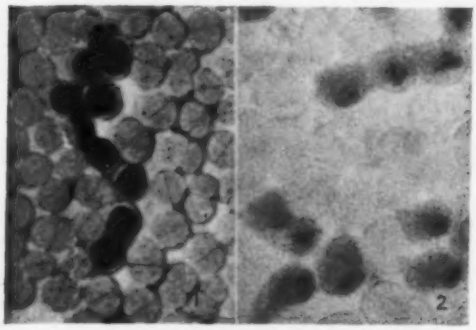

Fig. 1. Surface section through Enterococci (5-hr. culture). × *c.* 9,000

Fig. 2. Third section through Enterococci (5-hr. culture). × *c.* 12,000

I am deeply indebted to Prof. M. Siegbahn, who has constructed the microscope with which the pictures were taken and who has placed all facilities at my disposal, and to Prof. N. Hast, who encouraged me to use the beryllium as supporting membrane. The photographs were taken by Mr. Rosenquist.

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Polarization of Radiation from Distant Stars by the Interstellar Medium

Photometric observations for the detection of partially polarized radiation from eclipsing binary stars have been in progress at Yerkes Observatory, of the University of Chicago, for several years with the view of establishing observationally the effect pointed out by Chandrasekhar that the continuous radiation of early-type stars should be polarized[1,2]. On the assumption that the opacity of early-type stars is due to scattering by electrons, the continuous radiation emerging from a star should be polarized with a maximum of polarization of 11 per cent at the limb. Since the presence of this polarization can be detected only when the early-type star is partially eclipsed by a larger late-type companion of the system, the effect is masked by radiation from this companion, so that the expected maximum observable effect is only of the order of 1·2 per cent in the one case investigated (*RY* Persei).

However, the observations made in connexion with this problem have led to the detection of a new phenomenon which appears to have a bearing on the constitution of interstellar matter. Three Wolf–Rayet spectroscopic binaries (two of which are known to be eclipsing) in Cepheus were observed with the following results:

Star	Polarization	
	Per cent	Position angle
CQ Cep.	10·0	62
BD + 55° 2721	8·0	44
WN Anon*	12·5	44

* No catalogue number.

If the polarization were associated with the individual stellar systems, there should be a change in the polarization, in position angle and amount, with the phase of the binary motion. However, no such change was observed. In order to determine possible systematic errors in the receiving equipment, I investigated the polarization of comparison or control stars of similar colour and brightness. With the exception of *BD* + 55° 2723, no significant polarization was found in the control stars. *BD* + 55° 2723 gave 3 per cent polarization with a position angle of 44°. This particular star differs from the other control stars in that it is a giant, and is consequently more distant than the other control stars, which belong to the main sequence.

Similar observations were made on a group of Wolf–Rayet stars in Cygnus, which showed no significant polarization, while two stars in Scutum gave positive results. Other regions, such as the double cluster in Perseus, also show polarization with values ranging up to 12 per cent.

We conclude from the positive and negative results quoted that the measured polarization does not arise in the atmosphere of these stars, but must have been introduced by the intervening interstellar medium. If this conclusion is accepted, a new factor in the study of interstellar clouds is introduced. Further observations are in progress for relating this phenomenon with other observable characteristics of the interstellar medium. The results already at hand indicate that the plane of polarization approximates to the plane of the galaxy.

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Possibility of a Phase Transition in the Pure Helium Isotope of Mass 3

Sydoriak, Crilly and Hammel[1] have reported the preparation and separation of the pure helium isotope of mass 3. They have succeeded in condensing it and have determined its vapour pressure in the temperature range 1·21°–3·34° K. (the critical temperature) and its boiling point at 3·20° K. These vapour pressure measurements appear to have interesting consequences with regard to the possibility of a phase transition in the pure helium isotope of mass 3. They provide evidence for such a transition at 1·9° K. In this communication, the possibility of this transition is first examined, the vapour pressure equations in the two ranges 1·2–

1·9° K. and 1·9–3·20° K. are given, and a few remarks are made about the theoretical implications of the existence of a phase transition in the pure helium isotope of mass 3.

For a substance the vapour of which behaves as a perfect gas, the vapour pressure equation has the form

$$\log p = 2{\cdot}5 \log T + a/T + i, \qquad (1)$$

where i is the chemical constant. In fitting a curve of this sort to vapour pressure data for helium-4, it has been found[3] that the constants have nearly the theoretical values. This gives some confidence in using a formula of this theoretical form, and it seemed to be worth while to do so for the vapour pressure data for the pure helium isotope of mass 3. The simplest way to do this is to plot the values of

$$\log p - 2{\cdot}5 \log T \qquad (2)$$

as a function of $1/T$. When this was done for the data on helium-3, it was immediately apparent that all the data did not lie on a single straight line. The experimental points below about 1·9° K. were found to lie on one straight line, while those above 1·9° K. were found to lie on a different straight line, as shown in the accompanying diagram. Non-ideality of the vapour would give a curve convex to the axes, and if there is a wide scatter of the experimental points this may be the explanation. The reported values do adhere so closely to straight lines that it seems improbable that the experimental scatter has fortuitously caused this. The vapour pressure equations for pure helium-3 in the temperature ranges indicated were found to be

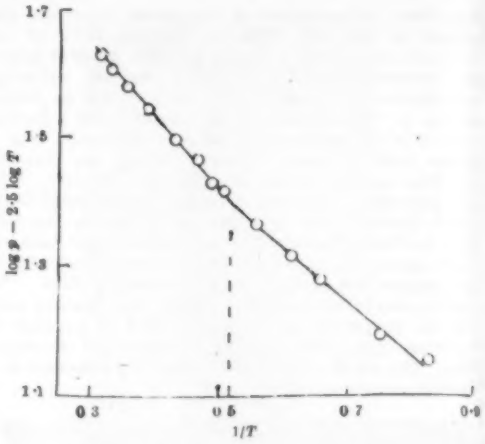
$$\log p = 2{\cdot}5 \log T - \frac{0{\cdot}79}{T} + 1{\cdot}795 \qquad (3)$$
$$(1{\cdot}21 < T < 1{\cdot}9° \text{ K.}).$$

$$\log p = 2{\cdot}5 \log T - \frac{1{\cdot}10}{T} + 1{\cdot}960 \qquad (4)$$
$$(1{\cdot}9 < T < 3{\cdot}20° \text{ K.}).$$

In the accompanying table the values of p calculated from equations (3) and (4) are tabulated against the corresponding experimental values. Comparison of the values given in the second and third columns of the table indicates the faithfulness with which equations (3) and (4) represent the experimental data.

The occurrence of the kink shown in the diagram of the plot of expression (2) against $1/T$ is consistent with what would be observed if pure helium-3 underwent a phase transition of the second or higher order at this temperature. The vapour pressure data which have been reported[1] suggest that pure helium-3 exhibits a phase transition at about 1·9° K. This conclusion must, however, be regarded as somewhat speculative until measurements of the physical properties (for example, specific heat, density) have been made. In particular, it would be worth while to look for discontinuities in their temperature variation in the neighbourhood of 1·9° K.

Temperature (° K.)	Pressure (mm. mercury) Calculated	Observed
1·211	22·5	23
1·334	33	32
1·524	54	54
1·635	70	70
1·795	98	99
1·977	139	141
2·047	158	159
2·152	190	195
2·327	253	255
2·580	364	366
2·817	493	495
3·032	630	634
3·201	756	764



The conclusion that the vapour pressure data indicates a lambda-transition in pure helium-3 is put forward with all due caution. In this connexion it must be remembered that the lambda-transition in the isotope of mass 4 was not deduced from any discontinuity in the temperature derivatives of the vapour pressure. For helium-4, such a discontinuity was, in fact, detected only after the phase transition at 2·19° K. had been discovered by other means. The discontinuity shown in the gradient of the vapour pressure measurements on helium-3 is greater than that shown by the vapour pressure of helium-4 at its lambda point.

It has generally been assumed that the lambda-transition in helium-4 is a manifestation of Bose-Einstein condensation. In this connexion it should be noted, however, that the Bose–Einstein condensation gives the wrong kind of transition[4], that it has never been demonstrated to exist for interacting particles and that 'demonstrations' of its existence for non-interacting particles are far from rigorous[5]. If helium-3 also shows a second-order phase transition, this would provide *prima facie* evidence that the *existence* of such a phase transition could not be a consequence of the particular quantal statistics obeyed by the assembly of particles. It would thus rule out any attempt at a theory of the phase transition in helium-4 which depends on the fact that helium-4 atoms obey Bose–Einstein statistics. It would be tempting to suggest that if helium-3 has a phase transition in the neighbourhood of 1·9° K., then below this temperature it will exhibit 'superfluid' properties analogous to those shown by helium-4 below 2·19° K., but no such conclusion can be deduced from the existing data. Although it is probable that below such a transition temperature helium-3 would have unusual properties, their precise nature could be determined only by experiments explicitly designed to examine this. The point is that, although a phase transition of the second order in helium-3 would indicate that the *existence* of such transitions is independent of the statistics obeyed by the assembly of particles, the particular properties shown by the assembly below the transition temperature may well depend on these statistics.

Note added in proof. In discussion of these results with Prof. Simon, he has pointed out that the slopes

of the two lines indicate that if the effect is genuine it corresponds to a *defect* of specific heat.

A. R. Miller

Royal Society Mond Laboratory,
Cambridge. Dec. 15.

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Crystal Structure of Strontium Laurate

Strontium soaps of even-*n* fatty acids from caproic to stearic were examined by X-rays; they exhibit several crystallographic forms. Form *A* is obtained by precipitation from an aqueous solution of a sodium soap; the long spacings follow a law, $d = 5{\cdot}879 + 2{\cdot}475\,N$, where N is the number of carbon atoms in the corresponding fatty acid. Form *B* follows a law, $d = 3{\cdot}95 + 2{\cdot}447\,N$; it can generally be obtained by heating *A*. The forms show a certain amount of variability of their powder patterns, the causes of which are not yet known. The increment of their long spacings indicates that in both forms the hydrocarbon-chain axes are perpendicular or nearly perpendicular to the ionic sheet planes; they differ in the structure of the ionic sheet or arrangement of the CH_3 end-groups rather than in their angle of tilt. Strontium caproate and one sample of myristate gave patterns indicating the existence of further forms.

Single crystals of the form *A* of strontium laurate were grown from alcoholic solution. They are long thin plates; a twinned crystal was also found. Rotation photographs, zero and higher layer Weissenberg photographs were taken about the *a* and *c* axes using nickel-filtered copper $K\alpha$ radiation. The crystals are monoclinic and the cell dimensions are: $a = 7{\cdot}803$ kX., $b = 70{\cdot}86$ kX., $c = 4{\cdot}75$ kX., $\beta = 102° 36'$; density (meas.) 1·27 gm./c.c., (calc.) 1·25 gm./c.c. (assuming four molecules $Sr(C_{12}H_{23}O_2)_2$ per unit cell).

There are many absent reflexions, including $(0k0)$ absent when k is odd and $(h0l)$ absent when $h + l$ is odd. The space group is thus probably $C_{2h}^5 - P2_1/n$. Further absences can be explained by assuming that for each atom at x, y, z, there is another atom at $\pm x \pm \frac{1}{2}, y + \frac{1}{2}, z$. This limits the position of the strontium atom to certain special positions. The chains are oriented along the *b*-axis, which roughly corresponds to the length of four fatty-acid chains.

The intensities of the reflexions were estimated by eye. The y co-ordinates of the atoms were approximately determined by a modified Booth method of steepest descents. The calculations were made on our mechanical structure-factor calculating machine. Probable signs of the $(0kl)$ reflexions were then obtained from the position of the strontium atom, and a Fourier projection on the *bc* face was prepared by trial and error. The average distance between two alternate carbon atoms in the undistorted part of the chain is 2·605 kX. This compares well with the distance 2·593 kX. found by us in potassium caprate.

We are indebted to Mr. T. R. Lomer for valuable help.

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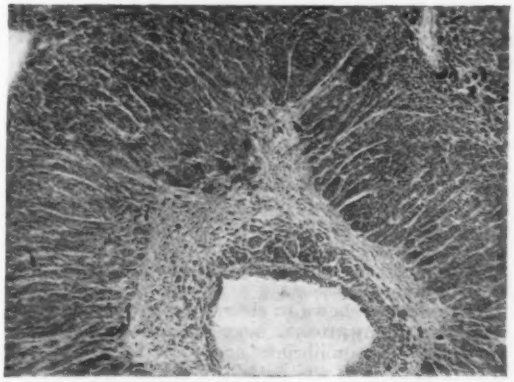
Histochemical Demonstration of Ketosteroids in the Adrenal Cortex

Various attempts have been made to develop a histochemical method for demonstrating the presence of ketosteroids within the cells of the adrenal cortex[1–7]. These have depended on the formation of coloured hydrazones of the ketosteroids. The low staining intensity of the hydrazones and the minute quantities of the ketosteroids present in the cells have rendered it difficult to locate with accuracy the chromogenic material except in relatively thick sections. Coloured compounds of much greater intensity can be produced if the aryl-hydrazones of the ketosteroids are coupled with diazonium salts. Any degree of solubility can be conferred on the final coupled compound by selecting the most suitable diazonium salt. This permits of the staining of blocks of fixed tissues, the use of paraffin embedding, counterstaining of the sections and clearing and mounting by the usual techniques.

An example of the use of this method is as follows. Formalin-fixed tissue, thoroughly washed in running water, is sectioned on the freezing microtome. The sections (5 μ) are allowed to remain overnight in a saturated aqueous solution of 2-hydroxy-3-naphthoic acid hydrazide[8] and washed in $N/100$ hydrochloric acid and then in distilled water to remove excess reagent, immersed in a solution of 0·4 per cent sodium hydroxide and transferred to a dilute solution of the diazonium salt. This may be prepared from a stabilized diazonium salt, or the following method may be used: 1 m. equiv. of the primary aromatic amine is dissolved in 2·5 ml. N hydrochloric acid (2·5 m. equiv.), and 70 mgm. sodium nitrite (1 m. equiv.) dissolved in 1 ml. distilled water is added to bring about diazotization. Excess nitrous acid would lead to rupture of the hydrazone linkage[9] and is disposed of by the use of sulphamic acid. Approximately 0·5 ml. of the diazonium salt solution added to 250 ml. of distilled water provides a suitable concentration for coupling. If the diazonium salt solution is too strong, staining tends to be patchy. The sections may then be counterstained, cleared and mounted in the usual way. The intensity of the reaction is improved if, before coupling, the sections are put into distilled water to which tincture of iodine is added until a faint straw colour is obtained. After five minutes, 1 per cent sodium thiosulphate solution is added, drop by drop, until the solution is cleared. The distribution of the coloured material in otherwise



Section of human adrenal gland, stained with 2-hydroxy-3-naphthoic acid hydrazide coupled to tetrazotized benzidene. (× 40)

unstained adrenal tissue is illustrated in the accompanying figure. The specificity of this colour reaction for ketosteroids is being investigated.

The principle of coupling the hydrazones of ketosteroids with diazonium salts to form coloured azo-derivatives has been found to be applicable also to the investigation of the ketosteroids of body fluids. Estimation of the ketosteroids may be carried out either by fluorimetry of the hydrazones or by colorimetry of the azo-derivatives. Chromatographic separation of mixtures of ketosteroids is possible by using a diazonium salt with the necessary solubilizing properties. The intense colour of the azo-derivatives renders their recognition easy, even when present only in small amounts. Alternatively, chromatographic separation of the hydrazones of the ketosteroids can be effected. The migration of these compounds can be followed by making use of their fluorescence under ultra-violet light. Work along these lines is proceeding.

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Reversible Action of D.D.T.

Some unusual relationships between temperature, cuticle permeability, and metabolic activity have emerged from a study of the action of D.D.T. on resistant insects. Observations that the primary stages of D.D.T. poisoning are reversible have provided a clue to the mode of action of this substance and related compounds, which is analogous to that of liquid fat-solvent narcotics. The supporting evidence may be briefly summarized as follows.

Mature *Calliphora erythrocephala* blowfly larvæ were extremely resistant to the contact action of excess crystalline D.D.T., and they pupated and metamorphosed normally within two to three days (20° C.). Paralysis followed exposure to a higher temperature (36° C.) for two hours, but only after the temperature was lowered (20° C.). The larvæ recovered when the temperature was raised. The experiment shows that the permeability of the cuticle to D.D.T. is increased at high temperatures, and since the uptake of crystalline D.D.T. involves a solubilization in the cuticle lipids, the change is consistent with an increase in the mobility of the lipid molecules in the outer epicuticle[1].

The response shown to change in temperature was reversible many times, suggesting that paralysis represents an equilibrium condition in which the D.D.T. present in the cuticle lipids acts selectively on the peripheral nervous system, for there was no interference with pupation, or with metamorphosis. The equilibrium condition may be varied experimentally by: (*a*) detoxication of D.D.T. at the site of action, (*b*) increase in the storage capacity of the cuticle lipids by fat-solvent action, and (*c*) decrease in the storage capacity of the lipids by adsorption displacement of the more mobile components on to 'inert' adsorbent powders. Factors (*a*) and (*c*) antagonize D.D.T. activity; (*b*) increases D.D.T. activity.

(*a*) When the cuticles were painted with a solution (5 per cent) of caustic potash, the paralysed larvæ recovered almost immediately. Presumably the D.D.T. inside the cuticle was hydrolysed *in situ* to the inactive derivative, α*x*-*bis*-(*p*-chlorophenyl)-ββ-dichloroethylene[2]. This detoxication response indicates that interference with metabolism is primarily reversible.

(*b*) When immersed in a solution (2 per cent) of D.D.T. in kerosene, *Calliphora* larvæ were paralysed within twenty to thirty minutes (20° C.). They did not recover when the temperature was raised. Under these conditions, the kerosene alone is inactive, but it greatly increases cuticle permeability, so that a higher concentration of D.D.T. accumulates at the peripheral nervous system[3].

(*c*) Adult *Calliphora* flies were paralysed rapidly (15–20 min.; 20° C.) by contact with excess crystalline D.D.T.; but if they were first sprinkled lightly with fine alumina powder, the time for the onset of paralysis increased two to four times; chalk and talc, which do not adsorb the cuticle lipids, increased paralysis time slightly by a physical diluent action on the D.D.T., which was overshadowed by the adsorption effect with alumina[1]. Partial recovery from paralysis occurred when the temperature was raised, and the effect was reversible.

These results may be interpreted in terms of the dynamic balance between a rate of D.D.T. activity and a rate of metabolism, both being dependent on temperature. With the resistant larva, the temperature coefficient of D.D.T. activity is smaller than that of metabolic activity, so that the critical metabolic level essential for nervous co-ordination is attained at high, but not at low, temperatures. The reverse relationship holds for kerosene-sensitized larvæ and flies, where D.D.T. activity remains a limiting factor with temperature change; the insects do not respond to a rise in temperature, or to treatment with alkali. Alumina treatment decreases the coefficient of D.D.T. activity, so that the temperature response is shown.

A guide to the nature of the interference in oxidative metabolism was obtained from the observations that the symptoms of D.D.T. paralysis are very similar to the unco-ordinated 'tremors' shown by insects recovering from the narcotic effects of ether, chloroform, or amyl alcohol. It is generally agreed that fat-solvent narcotics exert a relatively non-specific action on intracellular respiratory systems by inhibiting the dehydrogenase systems, such as succinic dehydrogenase, which reduce cytochrome, and these reducing systems show a high temperature coefficient of activity[4]. The average rate of uptake of oxygen by mature *Calliphora* larvæ at 20° C. (measured by a metal micro-respirometer of the type described by Crisp and Thorpe[5]) was found to be 23·6 c.mm./gm./min.; after paralysis by contact with crystalline D.D.T. at 36° C. for two hours, it fell to 7·8 c.mm./gm./min. Changes in respiration-rate and the degrees of recovery from paralysis were compared after injection of sodium succinate, pyruvate, lactate and glucose into the blood of larvæ from the same batch

of paralysed insects (dosage per insect, 0·15 c.c. 1 per cent solution in phosphate buffer, *p*H 7·4). Succinate induced complete, and glucose partial, recovery; lactate and pyruvate were ineffective. The uptakes of oxygen after injection were: succinate, 17·8; glucose, 11·2; pyruvate, 7·2; and lactate, 6·9 c.mm./gm./min.

Narcosis produced by injection of 0·4 per cent chloroform, 1·0 per cent ether, or 0·6 per cent amyl alcohol (0·15 c.c. aqueous solution) into the blood of mature larvæ was also antagonized by simultaneous injection of 1 per cent succinate; but not by glucose, lactate, or pyruvate. After succinate injection, adult blowflies became considerably more resistant to the narcotic action of these fat solvents applied internally by injection, or externally in vapour form. Flies treated externally with alumina and internally with succinate remained active in the presence of crystalline D.D.T. for several hours, showing clearly the combined influence of permeability and metabolic factors on D.D.T. activity.

These results show that the cuticle lipids play an important part in influencing the selective action of D.D.T. at the peripheral nervous system; but the action is primarily reversible and analogous to the narcotic actions of fat solvents, involving an interference with the utilization of succinate, an essential metabolite in oxidative metabolism. Succinate antagonism has also been observed with analogues of D.D.T., and with the structurally unrelated 'Gammexane' (γ-hexachlorocyclohexane).

A full account of this work will appear elsewhere.

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[2] Martin and Wain, *Nature*, **154**, 512 (1944).
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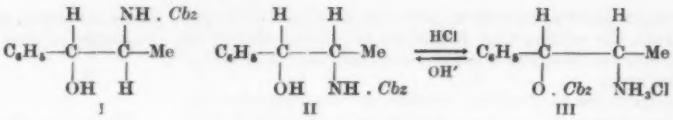
Separation of Diastereoisomeric Amino-Alcohols

The separation of diastereoisomeric amino-alcohols is of importance as they have very different pharmacological properties. Hitherto fractional crystallization has been used as the only suitable method for this purpose; however, sometimes, for example, in separating *nor*-ephedrine from *nor*-ψ-ephedrine[1], it proved to be unsatisfactory.

We have devised a new method of separation based on the different behaviour of diastereoisomeric N-acyl-amino alcohols towards alcoholic hydrogen chloride[2,3]. When a mixture of N-benzoyl-*dl-nor*-ephedrine and of N-benzoyl-*dl-nor*-ψ-ephedrine was treated with nearly the equimolar amount of this reactant, the former amide could be recovered unchanged, whereas the latter was quantitatively converted—due to an acyl shift N → O—into O-benzoyl-*dl-nor*-ψ-ephedrine hydrochloride. This water-soluble salt was easily separated from the insoluble amide in good yield. The same method also proved useful in separating amino-alcohols of other type; for example, N-benzoyl ephedrine and N-acetyl-1.2-diphenyl-amino-ethanol from their stereoisomers.



$Cbz = C_6H_5 . CH_2OOC—$

However, the conversion of the separated acyl derivatives into the appropriate amino-alcohols by acid hydrolysis may sometimes effect Walden inversion[4]; on the other hand, alkaline deacylation could result in a cleavage to aldehydes[5]. To avoid this difficulty, we attempted the separation of N-carbobenzoxy derivatives of diastereoisomeric amino-alcohols with subsequent removal of the protecting group by hydrogenolysis, that is, under very mild conditions. We succeeded in separating N-carbobenzoxy-*dl-nor*-ephedrine (I, m.p. 103°) from N-carbobenzoxy-*dl-nor*-ψ-ephedrine (II, m.p. 83°) on converting the latter by acyl migration N → O into the water-soluble hydrochloride of O-carbobenzoxy-*dl-nor*-ψ-ephedrine (III, m.p. 229°); this furnished on alkalinization (owing to a reverse acyl migration O → N) the N-carbobenzoxy derivative (II, m.p. 83°). As expected, hydrogenolysis afforded from the separated carbobenzoxy derivative I the amino-alcohol *nor-dl*-ephedrine, from II *dl-nor*-ψ-ephedrine, with very good yields. This new method will be investigated with further types of amino-alcohols, and details will be published later.

This separation was made possible by the fact that in the molecule of the type of pseudo-ephedrine, more suitable steric conditions are available for acyl migration than in that of ephedrine. Obviously the hypothesis of free rotation around the simple C—C linkage in this series of compounds[6] appears to be invalid[7].

This theoretical problem will be treated in detail elsewhere[8].

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July 25.

[1] Hoover, F. W., and Hass, H. B., *J. Org. Chem.*, **12**, 506 (1947).
[2] Bruckner, V., Fodor, G., *et al.*, *J. Chem. Soc.*, 865 (1948).
[3] Welsh, L. H., *J. Amer. Chem. Soc.*, **69**, 128 (1947) reported differences concerning acetyl migration reaction-rates of N-acetyl ephedrine and pseudo-ephedrine by the action of hydrochloric acid in acetone.
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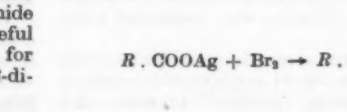
[5] Bruckner, V., *J. prakt. Chem.*, N.F., **142**, 301 (1935).
[6] Freudenberg, K., *et al.*, *J. Amer. Chem. Soc.*, **54**, 234 (1932).
[7] Bier, G., *Experientia*, **2**, 82 (1946).
[8] Fodor, G., *et al.*, *J. Org. Chem.* (in the press).

Reaction of Bromine with Silver (+)-α-Phenyl-propionate: an Electrophilic Bimolecular Substitution

In a review of the literature of the reactions of the silver salts of carboxylic acids with bromine, Kleinberg[1] has concluded that when one equivalent of salt reacts with two of bromine, an intermediate compound *R*.COOBr is formed,

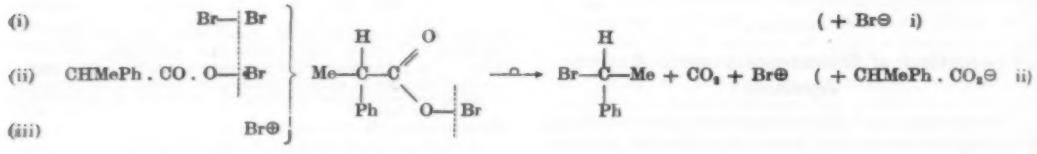


which decarboxylates to give the bromide *R*Br, and from the addition of *R*.COOBr to olefins and other reactions, that the bromine atom reacts as a 'positive' halogen.

In order to elucidate further the mechanism of the substitution of carboxyl by bromine, silver α-phenylpropionate, prepared from the acid having $\alpha D^{18°}$ + 42·3° (1, 0·5), optical purity 81·7 per cent, was allowed to react in boiling carbon tetrachloride with two equivalents of bromine; it gave, in good yield, α-phenylethyl bromide, $\alpha D^{18°}$ + 46·2° (1, 1·0), optical purity 35·2 per cent by comparison with the highest recorded rotation for this compound, $\alpha D^{18°}$ 131·4° (1, 1·0)[3].

The retention of asymmetry for this substitution is thus 43·1 per cent, and the following data permit comparison of the configurations of the acid and the bromide. (+)-α-Phenylpropionic acid has been converted with retention of configuration to (−)-α-phenylethylamine by the Hofmann and other rearrangements[3]. The (−)-amine with nitrous acid yields (+)-α-phenylethyl alcohol with considerable racemization[4]: it is considered that during this reaction the diazonium ion $CHMePh.N_2^{\oplus}$ dissociates into nitrogen and the ion $CHMePh^{\oplus}$, and that the latter reacts with water to form the alcohol with a preponderance of the inverted configuration, due to shielding of the original point of attachment by the released nitrogen molecule. Finally, (+)-α-phenylethyl alcohol and (+)-α-phenylethyl bromide have the same configuration[5]. Thus (+)-α-phenylpropionic acid and (+)-α-phenylethyl bromide have opposite configurations, and the silver salt – bromine reaction proceeds with inversion of configuration.

The following mechanism for the reaction is put forward: the molecule CHMePh.COOBr is first formed and then, by reaction with bromine (i), or with a second similar molecule (ii), the ion $Br^{\oplus}$ is formed in small concentration; thereafter reaction proceeds by (iii), a chain-reaction regenerating $Br^{\oplus}$:



The α-phenylethyl bromide formed by this mechanism would be fully inverted; the bromide obtained experimentally was inverted but partially racemized.

α-Phenylethyl bromide, $\alpha D^{17°}$ 96·6° (1, 1·0), was dissolved in carbon tetrachloride and heated under reflux for one hour with silver bromide and a small quantity of bromine; the α-phenylethyl bromide recovered from this solution had $\alpha D^{18°}$ 0·2° (1, 1·0). Racemization may have occurred either by bimolecular halogen exchange or by a radical reaction:

$$R\text{Br} + \text{Br}_2 \rightarrow R^{\bullet} + \text{Br}_2 + \text{Br}^{\bullet} \quad ; \quad R^{\bullet} + \text{Br}^{\bullet} \rightarrow R\text{Br}.$$

From this observation it is concluded that the bromide of the original experiment was racemized after its formation.

The silver salt – bromine reaction is a bimolecular substitution with inversion of configuration effected by electrophilic reagents, 'positive' bromine and bromine anion, and appears to be the first established example of this class of replacement reaction.

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[1] Kleinberg, J., *Chem. Rev.*, **40**, 381 (1947).
[2] Gerrard, W., *J. Chem. Soc.*, 741 (1946).
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[4] Holmberg, B., *Ber.*, **45**, 997 (1912). Campbell, A. (unpublished results).
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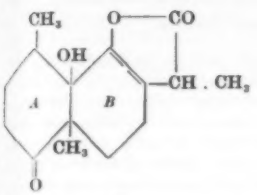
Desmotropo-ψ-Santonins

The butanolide structure proposed by Clemo and Cocker[1] for desmotropo-ψ-santonin (II) [p. 289], which is formed by the action of warm 55 per cent sulphuric acid on ψ-santonin, has been confirmed (compare Cocker and Lipman[2]). An intermediate compound in this transformation is now named ψ-santonic acid, to which structure (III) is tentatively assigned. Assuming that the most likely structure for ψ-santonin is (I), the conversion of this to (II) involves the destruction of asymmetry at C_1, C_5 and C_{10}. In addition, C_6 and C_9 will also be affected during the reduction of ring *B*, which probably takes place by bond migration. By the nature of the acidic reagent involved in the re-arrangement, it is most unlikely that the configuration of C_{11} will be affected. Hence the conversion of ψ-santonin to desmotropo-ψ-santonin should lead to two pairs of diastereoisomers in both of which the configuration of C_{11} should be the same. Two of the latter should have the *cis* configuration and the other two the *trans* configuration at C_5—C_9.

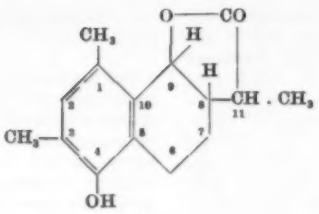
The conversion of ψ-santonin to desmotropo-ψ-santonin is now found to yield a mixture of desmotropo compounds. Crystallization of this mixture yields the desmotropo compound (m.p. 189°; $[\alpha]D^{20°}$ + 68°) already described, which we now name + β-desmotropo-ψ-santonin, in accordance with the nomenclature of Huang Minlon *et al.*[3], and a second desmotropo compound + α-*iso*-desmotropo-ψ-santonin, m.p. 251–253°; $[\alpha]D^{20°}$ + 68·5°.

When + β-desmotropo-ψ-santonin is heated in boiling anhydrous xylene with anhydrous potassium carbonate, it gives + α-desmotropo-ψ-santonin (m.p. 171–172°; $[\alpha]D^{20°}$ + 153°). The new compound is probably produced by the inversion of C_{11} through the enol, and it is unlikely that C_5 and C_9 are affected. The lactone ring is, in fact, not opened.

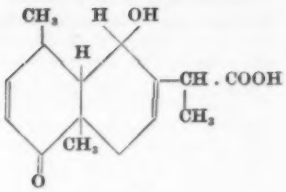
When + α-*iso*-desmotropo-ψ-santonin is treated in a similar manner or heated above its melting point, a fourth dextrorotatory desmotropo compound, + β-*iso*-desmotropo-ψ-santonin (m.p. 268–270°; $[\alpha]D^{20°}$ + 165°) is obtained.



(I)



(II)



(III)

We have thus obtained the four possible dextro forms. So far, attempts to invert C_8 and C_9 by acidic reagents have either yielded unchanged compounds or intractable mixtures; but further work on this point is in progress.

The work described forms part of a much wider investigation on the structure of ψ-santonin, the results of which will shortly be submitted for publication elsewhere.

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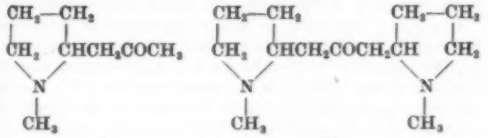
[1] Clemo and Cocker, *J. Chem. Soc.*, 30 (1946).
[2] Cocker and Lipman, *J. Chem. Soc.*, 533 (1947).
[3] Huang Minlon, Lo and Chu, *J. Amer. Chem. Soc.*, **65**, 1780 (1943). Huang Minlon, *J. Amer. Chem. Soc.*, **70**, 611 (1948).

Syntheses of Hygrine and Cuscohygrine

IN his theory of the phytochemical synthesis of alkaloids published in 1917, Robinson[1] suggested that hygrine (I) and cuscohygrine (II) were formed by the condensation of acetone dicarboxylic acid with one and with two molecular proportions respectively of γ-methylaminobutyraldehyde.



(I) (II)

Robinson's theory became widely known and is frequently stated in text-books; but no attempt to carry out these reactions seems to have been made for nearly twenty years. Then in 1936 he[2] announced that "a synthesis of *dl*-hygrine on these lines has proved feasible", but so far as we are aware no account of this synthesis has appeared. Later, Schöpf[3] reported that he was unable to obtain *nor*hygrine from γ-aminobutyraldehyde and acetoacetic acid, although the phenyl analogue of this base was formed from the same aldehyde and benzoylacetic acid.

We have now found that acetone dicarboxylic acid condenses smoothly with two molecular proportions of γ-methylaminobutyraldehyde at *p*H 7 to produce cuscohygrine in excellent yield. The identification of the product was made by direct comparison of several of its derivatives with authentic specimens and by the agreement of the analytical figures with the calculated values. Similarly, we have obtained from the reaction between excess acetoacetic acid and γ-methylaminobutyraldehyde a base which we believe to be *dl*-hygrine. The physical constants of the base and its derivatives agree with the values recorded in the literature, and the analytical figures also accord with the calculated values. Although we have not yet had the opportunity of making direct comparisons with authentic specimens, there can be little doubt that the synthetic product is *dl*-hygrine.

Full details of this work, including a discussion of the stereochemistry of cuscohygrine, will be published shortly.

We are greatly indebted to Prof. R. L. Shriner of the State University of Iowa for the provision of a sample of authentic cuscohygrine.

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[1] Robinson, R., *J. Chem. Soc.*, 876 (1917).
[2] Robinson, R., *J. Chem. Soc.*, 1079 (1936).
[3] Schöpf, C., *Z. Angew. Chem.*, **50**, 797 (1937).

I WOULD like to congratulate the authors on these syntheses, which are fundamental for the theory. My own synthesis, mentioned in 1936, employed acetonedicarboxylic acid in excess, but was otherwise identical. Though the product was undoubtedly *dl*-hygrine, the opportunity to add the final touches necessary for publication did not occur.

It is very satisfactory that this synthesis will now be placed on record and will become available for reference.

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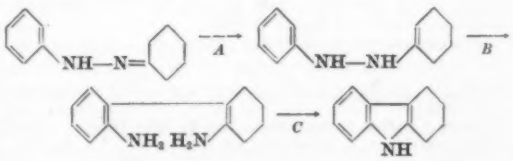
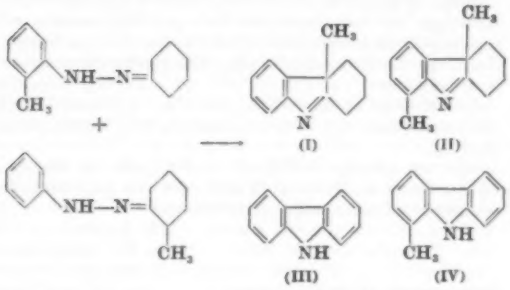
Mechanism of the Fischer Indole Synthesis

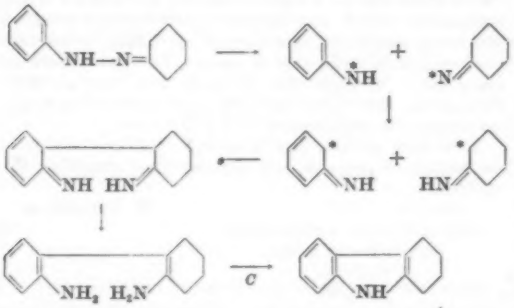
THE mechanism previously proposed[1,2] for the Fischer indole reaction has assumed that the intermediate stages involve an *o*-benzidine-type re-arrangement. This may be illustrated as follows, considering, as an example, the phenyl hydrazone of *cyclo*hexanone:



Ingold[3] has clearly shown that the benzidine re-arrangement is intramolecular in nature, but it has now been found that the Fischer indole synthesis proceeds by an intermolecular reaction. This fact was proved by studying the cyclization of a mixture of equal weights of the *o*-tolyl hydrazone of *cyclo*hexanone and the phenyl hydrazone of 2-methyl *cyclo*hexanone in boiling glacial acetic acid solution. The basic products formed in this reaction were 11-methyl- (I) and 8 : 11-dimethyltetrahydrocarbazolenine (II), and the neutral products gave, after dehydrogenation, carbazole (III) and 1-methyl carbazole (IV). These four products were formed in practically equivalent proportions.



Thus it is apparent that fission of the N—N linkage has taken place and that an intermolecular reaction is involved. The full implications of these results, and the importance of certain by-products from *o*-halo-substituted phenylhydrazones of *cyclo*hexanone[4], will be discussed in detail elsewhere. The provisional mechanism proposed may be formulated as shown :



Alternatively, stage *A* (see above) may occur initially, but, in either case, the same intermediate is formed as that resulting from stage *B* (an *o*-benzidine re-arrangement).

The validity of this free radical mechanism, as opposed to an ionic mechanism, is being tested by kinetic evidence.

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[1] Robinson and Robinson, *J. Chem. Soc.*, **113**, 639 (1918); **125**, 827 (1924).
[2] Allen and Wilson, *J. Amer. Chem. Soc.*, **65**, 611 (1943).
[3] Ingold and Kidd, *J. Chem. Soc.*, 984 (1933).
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Polarography with Slowly Forming Mercury Drops

By means of a capillary greatly restricted in the stem but with an orifice radius of 108 μ, it has been found possible to study current – time and current – voltage curves for single mercury drops with ordinary polarographic equipment—a Cambridge polarograph with photographic recording. Drop-times in a given solution could be varied between 16 sec. and 8 min. and were reproducible. The drop-weight in 0·1 *N* potassium chloride was about 28 mgm. The results show the change in character of current – time curves at constant voltage as the voltage is altered, give accurately measurable values for current – time relations during cathodic reduction, and indicate a new use for the polarograph in quantitative analysis by reason of the appearance of non-suppressible maxima on current – voltage curves.

The current – time curves of growing drops with no reducible matter present show that the current gradually rises when the applied potential is positive to that of the electrocapillary maximum, but that it gradually decreases when the potential is more negative, the falling-off of a drop being accompanied by a sudden downward jump of current in the first case and a sudden upward jump in the second. With sodium sulphite and zinc sulphate in oxygen-free potassium chloride solution, current – time curves at successively increasing negative potentials (*vs.* saturated calomel electrode) show that inversions of shape occur between − 0·1 and − 0·2 V., − 0·4 and − 0·6 V. (at the electrocapillary maximum), and − 0·9 and − 1·1 V. (deposition of zinc); for example, the current decreases with drop growth at − 0·1 and − 0·7 V., and increases with drop-growth at − 0·3 V. and − 1·2 V. The occurrence of such effects, which are also observable with normal capillaries (drop times 2–7 sec.), should have, *inter alia*, some bearing on the method of measuring wave-heights, but a study of numerous papers has failed to reveal that workers realize their existence.

Current – time curves for reductions at constant applied potential approximate closely to ordinary parabolas, $i \propto t^{1/2}$. This fact conflicts with conclusions derived from the Ilkovic equation ($i \propto t^{1/6}$), but it accords qualitatively with Steghart's findings[1] in the case of a rapid-dropping capillary studied by means of a high-speed, high-precision recorder.

Current – voltage curves during the life-time of a single drop over the range corresponding to a reduction show a current-peak in place of the initial part of the usual flat diffusion-current portion of the polarographic curve. The peak is not a polarographic 'maximum' since it is not removable by a maximum suppressor and the peak currents do not appear with drops taken at constant potential. With a given solution the peak-height increases with the size attained by the drop at the potential of the peak, and is linearly related to the volume and not the surface area of the drop. The maximal values of the peaks obtained at various drop-rates are identical. The peak potential is independent of the size of the drop at the peak when the rate of flow of mercury is kept constant, but it becomes more negative as the rate of flow is increased.

If the potential rise is started at the same size of drop-growth in solutions containing various amounts of reducible matter, the peak height is proportional to the concentration. The records obtained, for example, with Cd^{++} and Zn^{++}, are smooth steep curves

rising to well-defined peaks, the heights of which can be measured with much greater certainty than ordinary step-heights.

With special equipment for very rapid application of potential and oscillographic recording, Matheson and Nichols[2] and, later, Randles[3], found peaks on current–voltage curves obtained with normal capillaries. The present results are given by the usual slow rate of application of potential, and no special equipment other than the capillary is required. The investigation is being continued and details will be given elsewhere.

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[1] Steghart, F. L., in contribution to a discussion, *Analyst*, **72**, 234 (1947).
[2] Matheson, L. A., and Nichols, N., *Trans. Electrochem. Soc.*, **73**, 193 (1938).
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Mercury Photosensitized Reaction of Tetrafluoroethylene

I HAVE found that the irradiation of tetrafluoroethylene in the presence of mercury vapour by light of wave-length 2536 A. causes a mercury photosensitized reaction. The pressure falls and a white powder is formed. A gas of molecular weight 150 ± 1, b.p. − 33° C., m.p. − 80° C., believed to be hexafluoro*cyclo*propane, molecular weight 150, b.p. − 31° C.[1], and a small quantity of a mixture of compounds with higher boiling points have been isolated from the products of the reaction. The white powder has properties similar to those of polytetrafluoroethylene $(CF_2)_n$ [2], the product of the catalysed polymerization of tetrafluoroethylene.

The quantum efficiency of the reaction at various pressures has been measured. At pressures below 10 cm. of mercury, quenching of the mercury fluorescence is not complete, and only very approximate calculations of quantum efficiency can be made. Some of the quantum efficiencies obtained are given in the accompanying table.

Temperature (° C.)	Initial pressure (cm. mercury)	Light absorbed (quanta/hr. × 10^{-16})	$\eta_{C_3F_6}$	φ_P
29·8	10·43	1·33	0·03	0·18
29·8	33·61	1·38	0·32	0·30
29·8	8·01	91	0·017	0·02
29·8	35·03	104	0·07	0·12

$$\eta_{C_3F_6} = \frac{\text{molecules } C_3F_6 \text{ formed}}{2 \times \text{quanta absorbed}}; \quad \varphi_P = \frac{\text{molecules } C_3F_6 \text{ polymerized}}{\text{quanta absorbed}}$$

The quantum efficiency of hexafluoro*cyclo*propane production increases with increasing pressure and decreases with increasing intensity. As this compound is the main product, one of the primary reactions must involve the breaking of a carbon–carbon bond. The formation of a polymer indicates the presence of free radicals in the system, and the decrease of efficiency of perfluoro*cyclo*propane production with increasing intensity can be accounted for only by a radical recombination reaction. The results obtained are in accord with the following reaction scheme.

$$C_2F_4 + Hg(^3P_1) = 2CF_2 + Hg(^1S_0); \quad (1)$$
$$CF_2 + C_2F_4 = C_3F_6; \quad (2)$$
$$2CF_2 + C_2F_4 = 2C_2F_4; \quad (3)$$
$$CF_2 + CF_2 = C_2F_4 \text{ (at the walls)}. \quad (4)$$

Reaction (2) is probably the reaction initiating polymer formation.

A surprising feature of the reaction is that the 112 k.cal. per gm. mol. available from the excited mercury atoms is sufficient to cause the carbon–carbon bond to break. The bond-energy of the double bond in ethylene is stated to be 153 k.cal. per gm. mol.[3] If the double bond in tetrafluoroethylene has about the same bond-energy, reaction (1) can take place only if the bond-energy of the carbon–fluorine bond in the difluoro-methylene radical is approximately 10 k.cal. higher than the corresponding bond-energy in tetrafluoroethylene. The reaction of tetrafluoroethylene may be contrasted with the mercury-photosensitized reaction of ethylene, in which acetylene and hydrogen are the primary products[4].

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An Outline of a Theory of Detonators

FURTHER to the reported property of silver formate of detonating at 85–90° [1], it is perhaps opportune to offer some commentary on the nature of detonators in general. They are commonly derived from acids, the anions of which are the repositories of considerable stores of energy. This is liberated when the anions are discharged and the radicals, thus initially produced, decompose. Anodic discharge from aqueous solution is obviously one method of achieving this, and Audubert has recorded that such discharge of the azide ion is accompanied by liberation of light energy[2]. Another mode of discharge, illustrative of the possible application of these ideas to the picrates, is represented by the action of lead tetracetate on various *para*nitrophenoxide ions, leading to their decomposition into nitric oxide and *para*quinone[3]. In detonators, such anions are associated with heavy metallic cations in what may be approximately described as covalent union[4], and this constitutes a stage in the transition from the fully charged anion to the unstable radical. The process of transition is completed by a suitable supply of energy in the form of a blow, heat or otherwise, and this stage is illustrated by the historic thermal decompositions of mercuric oxide and cyanide and by that of silver salts of carboxylic acids. Local decomposition of this kind in a mass of the detonator will liberate energy, which on communication to immediately adjoining material will cause further decomposition leading to detonation.

Regarding individual detonators, the fulminate ion $(CNO)'$, derives its energy from the abnormal arrangement of its atoms, as is clear from the fact that oxidation of cyanide ion yields cyanate ion $(OCN)'$. The fulminate ion, like the azide, formate and picrate ions, is stabilized by resonance; but the

double negative charge by itself accounts for the existence of the acetylide ion[5].

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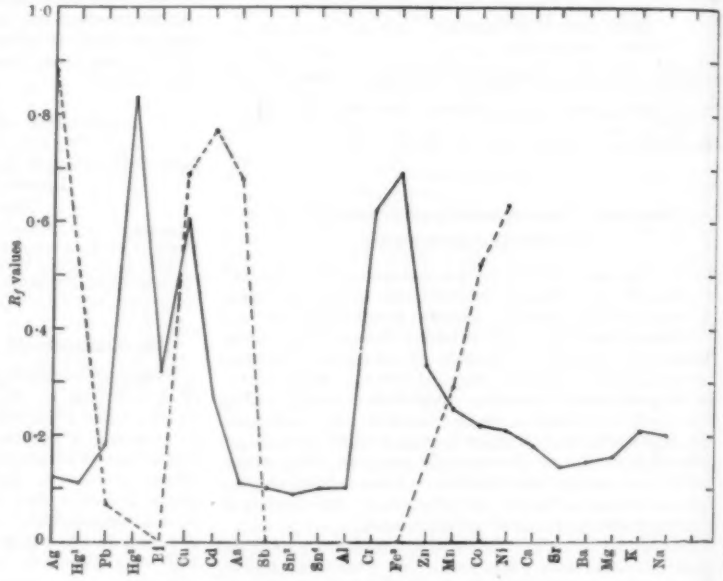
[1] Keller and Kőrösy, *Nature*, **162**, 580 (1948).
[2] *Bull. Soc. Chim.*, **7**, No. 5, 907 (1940).
[3] Jones and Kenner, *J. Chem. Soc.*, 1842 (1931).
[4] Cf. Pauling, "Nature of the Chemical Bond", 195 (1st edit., 1939).
[5] Cf. Allsop and Kenner, *J. Chem. Soc.*, 2299 (1923).

Inorganic Paper Chromatography and Detection of Cations by Fluorescence

THE importance and potentialities of the paper chromatographic separation of inorganic cations have already been indicated by recent communications of Linstead[1] and Lederer[2]. In this laboratory we have been working along similar lines, but with the object of finding general methods of separation and identification, rather than specific methods for two or three ions. Such a scheme has obvious advantages in qualitative analysis.

Our technique is essentially that already described for organic substances by Martin and Synge[3], using Whatman No. 1 filter paper; drops sufficient to give spots of ½ cm. in diameter being placed 4 cm. apart. The solutions were usually approximately $N/10$ in acetic acid. In this way, tests for at least twenty-four cations at a time can be performed and compared with the unknown.

A variety of solvents has been tried, and the relative R_f values, determined under the conditions of our experiments for two promising solvents, namely: *Solvent* 1, 50 per cent butanol, 10 per cent acetic acid, 5 per cent acetoacetic ester, 35 per cent water; *Solvent* 2, 50 per cent collidine fraction, 50 per cent water, are shown in the accompanying graph. This clearly illustrates the separations possible, and it will be seen that the differential effects of two solvents open up the possibility of two-way separations.



Full line, butanol mixture; broken line, collidine mixture

The location of the cations on the paper can be revealed by hydrogen sulphide in some cases; but we have found the use of fluorescence a very marked advantage, since with suitable spraying reagents we can detect nearly all the cations of the ordinary qualitative tables. Our procedure is to spray the dry paper with the selected reagent, allow it to dry and then examine it under the ultra-violet lamp; some of the spots fluoresce and others appear dark through quenching of the fluorescence. From a large number of trials, the following reagents proved most successful: kojic acid, *o*-aminobenzoic acid, morin, 1-naphthylamine-8-sulphonic acid, 2-naphthylamine-1-sulphonic acid. (*Note added in proof.* 8 hydroxyquinoline is extremely useful as a fluorescent reagent.) An interesting effect was noticed, particularly for kojic acid, on subsequent treatment of the paper with ammonia gas; this causes some dark spots to fluoresce (for example, Hg^{++}), quenches the fluorescence of others (for example, Mg^{++}), and makes others quite invisible (for example, As^{+++}). This was used to distinguish between various cations.

The mechanism involved in the separation seems to be essentially partition chromatography for the butanol mixtures, since water alone washes the ions down the paper, while butanol with 10 per cent glacial acetic acid produces almost no movement. Small quantities of acetoacetic ester or glycerol in the butanol mixture tend to concentrate the spots and prevent tailing. For solvents such as collidine, complex formation and adsorption probably have the dominant roles.

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Dec. 18.

[1] Linstead, *Nature*, **162**, 691 (1948).
[2] Lederer, *Nature*, **162**, 777 (1948).
[3] Martin and Synge, *Biochem. J.*, **35**, 1358 (1941).

Drinking Spouts for Laboratory Animals

LABORATORY rats are usually allowed to obtain their water from an inverted glass bulb with a stem, or from an inverted bottle fitted with a bung and spout. The bulbs are awkward to clean and refill, and are very easily broken. The bottles are satisfactory: but the bungs and spouts jam and break, with frequent minor casualties to attendants. The extension of watering to mice, rabbits, guinea pigs,

etc., necessitated by the use of diets in the form of dry pellets and cubes (Bruce and Parkes[1,2]), made urgent the elaboration of a more efficient water container.

We have therefore evolved a drinking spout which can be attached to the cap of almost any standard screw-topped bottle. The spout is made from ⅛-in. external diameter 18-gauge metal tubing. The distal end is rounded by spinning to form a vent about ⅛-in. diameter. The proximal end is threaded for about half an inch, and a thin hexagon nut is screwed on up to the end of the thread. The end of the tube is then passed through a ⅜-in. hole pressed in the bottle top and secured by a second nut inside the cap. Both nuts are coated with 'Bostic' to ensure an air-tight joint. A washer inside the cap ensures an air-tight joint with the bottle. Spouts of this type can be made of any appropriate length and shape.

Two types are now in routine use at the National Institute for Medical Research. The first is 6 in. in length with a slight bend, and is attached to the aluminium cap of the standard blood transfusion bottle for use with large cages (for example, rabbit cages), or to the cap of the standard 10-oz. flat bottle for use with smaller cages. The bend in the spout enables it to be used in the horizontal position on top of the cage or in the vertical position on the outside of the cage, to which it is attached by means of a wire holder. Where the cap of the bottle is large, as with the blood transfusion type, it should be strengthened with an 18-gauge disk inside each nut. The second type of spout is short (2 in.) and straight, and is used on the plastic cap of a small squat bottle (ink bottle type) for rat isolation cages or mouse boxes. The spouts can be moved from one type of bottle cap to another as required. The present spouts are made of 'Dural' tubing, and the price is very moderate. The short spout and squat bottle together cost about 25 per cent of the present price of the fragile glass bulb which they replace completely. It is likely, however, that the 'Dural' tubing will prove too soft for use with guinea pigs, and that brass spouts will be required for this species.

We are indebted to Dr. B. Wheeler Robinson for suggestions on design. The equipment described was made by Herbert W. Baker (Engineering), Ltd., St. John's Works, 2a Kilburn Lane, London, W.10.

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Oct. 30.

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Science in the East African Groundnut Scheme

Sir John Russell, stressing, in his address to the le Play Society at Oxford on December 31, the importance of adequate preparatory experimental work before developments such as the groundnut scheme are undertaken, is reported (*The Times*, January 1) as having said that the scientific and technical staff of the scheme "never really had a chance to do their work properly" and that they were "not allowed the necessary time" to make small-scale experiments to discover the snags and difficulties of the scheme. He is also said to have stated that "those who had been experimenting" in the scheme "were very disappointed with the results".

These reports may give rise to impressions other than those intended by Sir John Russell, and on two points in particular clarification is necessary.

First, it is true that the scheme was started in advance of any detailed experimental work in the areas concerned. This course was dictated by the urgency of the world food position, since it was believed on the technical information and experience available in 1946 that the general conditions were adequate for the economic production of groundnuts and other crops in the areas designated.

This proposition has from the first been under test. I was a member of the advance party which reached Tanganyika early in February 1947, and the scheme's Scientific Department, which now includes seventeen European scientific and technical workers, together with a growing corps of African scientific assistants, has carried out a considerable programme of soil and vegetation surveys, followed by laboratory and field studies of soil fertility, alternate cropping and rotations, and plant protection problems.

Three experiment stations, each of several hundred acres, have been developed in the central, western and southern provinces of Tanganyika. The headquarters, at Kongwa, include a tented laboratory, a library and a statistical section. These studies have done much to confirm the conclusions of the Wakefield mission on agricultural questions, at least so far as Tanganyika is concerned.

It is true, of course, that the scientific and technical effort will need considerable expansion if the problems of establishing, in a matter of ten years or so, a system of large-scale mechanized agriculture over millions of acres of new land in East Africa are to be dealt with adequately. The need is particularly acute in respect of laboratories. We meet, inevitably, many difficulties of supplies and communications; but we have been well supported by the management of the scheme, whether under the United Africa Company or the Overseas Food Corporation.

Secondly, the many delays and difficulties of the last two years, which are as disappointing to the technical staff as to all other workers on the project, are not in the main due to lack of technical information such as agricultural research can be expected to provide, nor, as has been alleged by some, to disastrous failures on the agricultural side. They arise in great part from engineering problems of clearing, construction, communications and general development, which have proved to be greater than was foreseen, and could not have been eliminated by small-scale research, since they are essentially problems of large-scale operation and organisation in new country. These very delays give us on the research side the more time to press forward our investigations.

This is not to say that the agricultural problems are negligible. They are many and important; some promise to give much trouble. Nevertheless the scientific and technical staff share with Sir John Russell, under whom many of us formerly served, the belief that we shall find the solutions.

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APPLICATIONS OF ELECTRONICS TO RESEARCH AND INDUSTRY

THE first Electronics Symposium of the Scientific Instrument Manufacturers' Association was held in the Caxton Hall, Westminster, during November 18–19. Mr. A. G. D. West, chairman of the Electronics Group of the Association, presided at the first session, and the proceedings were opened by Sir Edward Appleton, who expressed his belief in the great existing and potential importance of electronic techniques in industrial processes. He gave instances in which the introduction of such devices had secured savings of time and money out of all proportion to their cost. The Department of Scientific and Industrial Research had set up a small organisation to explore the field of potential application in industry and to advise on the design and supply of electronic equipments appropriate to the various particular problems they encountered.

The first paper in the symposium itself was by D. J. Mynall (British Thomson-Houston Co., Ltd.) on "Electronics in Computing". Present developments in automatic electronic computing machines can be classified as digital or analogic, according to whether they operate on numbers or on continuously variable quantities. The digital type, with its capacious 'memory' based on supersonic delay lines, cathode ray, or magnetic devices, has a very wide range of application, very great speed, and can give any desired accuracy; but its construction is correspondingly complex. Analogue computors, on the other hand, though generally simpler in construction, are inherently limited in accuracy. It was pointed out in the discussion that the larger types of electronic digital computor will open up new fields of pure and applied science, since they will, for the first time, make practicable the solution of problems which would otherwise need a prohibitive time for computation.

In the second paper, entitled "A Review of Frequency Measurement", by E. A. Rea Palmer and R. W. Darvill (Marconi Instruments, Ltd.), the relation between frequency, time and wave-length was discussed, and the customary division of the electromagnetic wave spectrum into bands was considered. Reasons were given for treating frequency measurement on a functional basis, the chief among them being that different accuracies are required in the various fields, which range from power engineering to ultra-high-frequency radio communications. Equipment can be divided into two groups: direct indicators with an accuracy not better than one part in 10^4; and comparison instruments in which the reference standard has a constancy better than one part in 10^7. The types of instruments appropriate to the various fields were enumerated, and some typical models were described and demonstrated. These included an 'electronic' meter of the limiter-counter type, for use at low frequencies, a high-precision comparison instrument for medium frequencies, a frequency synthesizer for high frequencies, tuned lines for very high frequencies and a crystal calibrator for the ultra-high-frequency band.

The first morning session concluded with a paper on "The Measurement of Small Displacements by Electrical and Electronic Means", in which R. E. Reason (Taylor, Taylor and Hobson, Ltd.) explained that transducers of high stiffness, such as piezo-electric crystals, are suitable for measuring force, while transducers of low stiffness, such as photo-electric or electromagnetic devices, are more appropriate for measuring position.

It was pointed out that electronic instruments, although capable of high magnification, are often unsuitable for workshop applications, where the requirements of low magnification, robustness and cheapness are more easily met by simpler electrical devices. On the other hand, certain types of application such as, for example, the measurement of surface finish, require electronic devices, since high magnification with very low stiffness is necessary. Some practical applications of electronic methods were illustrated by reference to various historical and commercial instruments.

Dr. A. J. Maddock took the chair for the afternoon session, which was opened by G. Syke (Baldwin Instrument Co., Ltd.) with a paper on the "Measurement of Ionizing Radiations". He described the operation of an ionization gauge comprising an ionization chamber, a capacitance or resistance, and a potential measuring device, the voltage across the capacitance or resistance being a measure of the dose or dose-rate respectively. Mr. Syke emphasized the advantages of negative feedback circuits in association with electrometer valves, and described several such circuits. Other instruments mentioned were those using vibrating reed electrometers, multiplier photocells, and Geiger–Müller tubes, the last-named being very suitable for detecting traces of radioactive materials. The principle of operation of the tube and its use with electronic pulse counters were described.

In the second paper, by W. Steckelmacher (W. Edwards and Co. (London), Ltd.), on "High-Vacuum Gauges", reference was made to instruments for measuring low gas pressures both in the research laboratory and in industry. For pressures down to 10^{-4} mm. of mercury, the Pirani gauge is valuable and may be used in a Wheatstone bridge network; alternative schemes making use of a thermocouple welded to the filament are available. The cold-cathode glow-discharge tube can be used in the range 5×10^{-3} to 10^{-6} mm. of mercury, an extension of the range to the low value quoted having been realized by the use of a magnetic field and a special electrode array which increases the opportunities for collision and thus augments ionization. Hot-cathode ionization gauges are effective at pressures down to 10^{-8} mm. of mercury under ideal conditions. They are similar in construction to ordinary triodes, but are used with the grid at a positive potential of about 100 volts and the anode at a negative potential of about 20 volts. For the most accurate measurement of very low pressures, the Knudsen gauge, which uses the direct principle of molecular momentum transfer, is recommended.

The McLeod gauge still remains the standard instrument, and may be used for pressures down to 10^{-4} mm. of mercury. The other types of gauges are calibrated by reference to the McLeod gauge, it being necessary at the lower pressure ranges to extrapolate readings. The indications of the McLeod gauge are subject to error when the system contains vapours.

One of the serious difficulties in the use of the ionization type of gauge is the reaction of the gauge on the system. In some cases the pressure in the vicinity of the gauge may be appreciably lower, in others appreciably higher, than the pressure in the rest of the system, depending on whether the gauge is producing gas or 'gettering'. The author indicated a possible error factor of 10, and concluded his paper with the statement that much work remains to be done to eliminate the difficulties at present confronting the accurate measurement of very low pressures.

In the next paper, on "The Radiosonde and its Applications", J. Foster Veevers (Salford Electrical Instruments, Ltd.) gave details of the processes and test procedures now adopted in the large-scale manufacture of the standard British instrument known as the Kew Mark II. This equipment, originally developed at the National Physical Laboratory and later modified by the Meteorological Office, is now in daily use for the collection of upper air data. To obtain a temperature accuracy of $\pm$ 1° F., a pressure accuracy of $\pm$ 5 millibars and a humidity accuracy of 10 per cent, great care has to be taken in the routine calibration of the instruments, and various special chambers have been constructed for this purpose.

On the second day of the meeting, emphasis was given to industrial applications of electronics, the chairman at this session being Mr. F. A. Downes.

In the first paper, on "Some Industrial Applications of Ultrasonics", D. O. Sproule (Henry Hughes and Son, Ltd.) pointed out that although a vast number of applications have been indicated in the literature, relatively few have so far resulted in devices of commercial value. The marine echo sounder was described and demonstrated, and extensions of its principle for industrial purposes were discussed, with particular reference to the location of flaws and the determination of the elastic constants of materials. The technique of non-destructive flaw detection was demonstrated, and the deduction of the elastic constants of a material from measurements of the velocity of propagation of both longitudinal and transverse vibrations was described. The process of grain refinement was outlined as a typical example of an application in which the objective is a permanent modification of the medium.

In the second paper, by G. S. Elphick, S. Y. Logan and A. R. Woods (Cinema Television, Ltd.), entitled "Metal Detection in Industry", an outline was given of the development of metal detection technique, from the war-time requirements of mine- and bomb-location to the latest industrial equipments currently in use. After summarizing present-day requirements, three detectors were described and the principles involved in their design were explained.

The first is a general-purpose detector of the regenerative type, for use in saw mills for locating metal in timber. The second is a variation of the first, and has been designed for pipe- and cable-location; while the third is a fully automatic industrial equipment in which frequency drift is automatically corrected. In this last instrument ferrous particles about $\frac{1}{8}$ in. in diameter or non-ferrous particles $\frac{1}{16}$ in. in diameter can be detected in materials travelling along a conveyor belt. This apparatus is finding increasing use in a wide range of industries as an inspection device, affording continuous protection for valuable plant, and an effective safeguard against the inclusion of metal in foodstuffs, pharmaceutical products, etc.

Introducing the third paper, on "Sound and Vibration Measurement in Industry", L. P. Corte (Dawe Instruments, Ltd.) stressed the increasing importance of noise control in industry, the first step towards which was the measurement of noise and vibration. He distinguished between the objective characteristics of noise, such as total intensity and the distribution of intensity with frequency, and the subjective characteristics such as loudness, pitch and annoyance. A range of instruments for objective measurements was described. A sound-level meter utilizing a piezo-electric microphone in conjunction with an amplifier and rectifier to measure the total intensity was described. In this instrument some account is taken of the characteristics of hearing, since the resistivity to low frequencies can be reduced at low intensity-levels in accordance with that of the ear.

A vibration meter was next described in which a piezo-electric pick-up is employed, of which the response is proportional to acceleration. A description was then given of an analyser which could be used with either the sound-level meter or the vibration meter. Finally, for the production of permanent records, a level recorder of the Neumann type was described, which gives a record on waxed paper on a decibel scale. A demonstration of the reproduction of the noises of trains, trams, etc., was much appreciated.

The chairman for the afternoon session was Mr. F. D. Hart, and a paper on "Electronics in Spectroscopy" was read by F. Holmes (Hilger and Watts, Ltd.). The development of direct-reading methods of spectrochemical analysis was outlined under the main headings of photocells, photomultiplier tubes, and thermopiles.

In Great Britain the lack of generally available photomultiplier tubes has caused attention to be directed to cæsium-type photocells; whereas in the United States complex and costly direct-reading spectrographs, based on photomultipliers, have been marketed. It is hoped that the supply position will be remedied by British manufacturers in the near future, although it still remains to be proved that the fundamental properties of this equipment offer any increase in accuracy over photographic recording for quantitative spectrographic analysis, and the advantage of speed of response may be illusory in view of rapid and localized fluctuations at the source.

For work in the infra-red region, a high-speed thermopile was described with a 90 per cent response within 15 milliseconds and an output of 50 microvolts per microwatt. A diagrammatic circuit of a direct-reading infra-red spectrometer based on this thermopile and a cathode ray tube was shown, and a separation of eight wave numbers at 10μ was claimed.

The lack of suitable ratio recorders was emphasized as a drawback to the double-beam system, and an outline of a suitable phase-sensitive recorder shown.

The final contribution to the symposium was by J. Bell (Muirhead and Co., Ltd.), who described "Some Developments in Picture Telegraphy". This paper, which was concerned entirely with the British equipment manufactured since the end of the War, has already been referred to in *Nature* of January 22, p. 145. At the symposium Messrs. Muirhead and Co. exhibited fixed and portable equipments, together with samples of pictures actually transmitted over telephone lines.

DUST IN INDUSTRY

CONFERENCE AT LEEDS

ABOUT two hundred delegates attended the Conference on "Dust in Industry" which was organised by the Society of Chemical Industry and held at the University of Leeds during September 28–30. The papers presented during the five sessions of the Conference covered a wide range of subjects and showed how dust problems enter into almost every major industrial process.

After a civic welcome by the Lord Mayor of Leeds, the delegates proceeded to the business of the first session under the chairmanship of Prof. H. V. A. Briscoe. Under the general title of "The Physical Characteristics and Estimation of Dust" the following four papers were presented: "Problems on the Design of Plant Handling or Producing Dust", by G. Nonhebel: "A Rapid Method of Dust Estimation in Iron and Steel Foundries", by B. W. Lawrie; "Dust Hazards in the Explosives Industry", by Prof. W. M. Cumming, Dr. F. Rumford and Dr. W. G. D. Wright; and, finally, "Particulate Clouds in the Gas Industry", by E. H. M. Badger.

Mr. Nonhebel made a broad survey of the processes in the production or control of fine particles. From his review of the factors concerned in such operations as grinding and classification, the separation of dusts from gases and liquids, mixing, aggregation and the size analysis of dust samples he pointed out the lack of knowledge in this field and the vast amount of fundamental work which is needed before the design of plant for such purposes can be established on a sound scientific basis.

Mr. Lawrie described a quick method of dust estimation suitable for survey work in iron or steel foundries or other industries where the dust concentrations encountered are so great that counting of samples taken by the thermal precipitator is frequently impossible. In brief, samples collected by the thermal precipitator or by the Owens jet counter are photographed on a projection microscope and compared visually with a standard scale of dust concentrations. While admittedly this method gives only an estimate of the dust concentration, it is claimed that it is entirely adequate for comparing the efficiency of dust control systems and that it gives as good an indication as may be obtained of the health risk in an industry. This work has shown, incidentally, that more accurate estimates of thermal precipitator slides can probably be made by counting a photographic record rather than by the usual direct visual count.

Prof. Cumming discussed the three main dangers of excessive dust concentrations in explosives factories —ignition, health hazards from contact or by inhalation of the dust, and dermatitis. Trinitrotoluene and tetryl show all these three dangers to a greater or lesser extent. He described a simple photo-electric method used for measuring the relative 'dustiness' of explosives, and also gave an account of colorimetric methods devised for estimating the concentration of airborne dinitrotoluene, trinitrotoluene and tetryl sampled by the standard D.S.I.R. pump. Trinitrotoluene and tetryl are absorbed in a mixed solvent of methyl ethyl ketone and *cyclo*hexanone containing a little potassium hydroxide, and estimated by comparison with standard colour disks.

Mr. Badger described how, in the separation of dust from producer-gas, trouble was experienced with the formation of stalactitic growths across the electrostatic precipitator plates. The difficulty has been overcome by the evaporation of a small amount of tar oil into the gas. This condenses and forms a liquid film around the dust particles, rendering the deposit fluid enough to run off the plates. Removal of much tar fog from gas takes place in the exhausters; but particles of above a certain critical size only are removed. The tendency for spontaneous condensation, producing small droplets, can be minimized by mixing pre-cooled gas with the main gas stream, thus introducing nuclei for condensation. A portable electrostatic precipitator used during this work was described.

The discussion centred around Mr. Lawrie's paper. The chief criticism of his method was that it does not differentiate chemically between the particles present in foundry dusts. The health hazard is primarily dependent on the silica content and not on the total dust count. The suggestion that it is a quick method suitable for use in dust surveys was endorsed by several speakers.

The second and third sessions, under the chairmanship of Dr. Julian M. Leonard and Mr. A. V. Hussey, were both devoted to "Practical Aspects of the Dust Problem". The four papers given during the second session were "Some Methods of Reducing Contact with Dusts in Chemical Manufacture", by L. Marsden, G. W. Robertson and Dr. R. A. Storey; "The Problem of Dust in the Chemical Industry", by G. Lowrie Fairs and E. Godfrey; "The Problem of Dust in the Cotton Industry", by Dr. D. W. Hill; and "Some Practical Methods of Industrial and Atmospheric Dust Elimination", by J. H. Hellyer and J. Cleeve.

Dr. Storey considered means of preventing the formation of, and removing, air-borne dust at its origin in a variety of unit operations involving the charging, processing and discharging of dry materials. He suggested that dealing with the problem in this way is preferable to applying individual protection for each operator.

Mr. Lowrie Fairs divided dust problems into three types and suggested means of dealing with each of them: (*a*) where dust produced at one stage may interfere with later stages in a process; (*b*) where escape of dust causes atmospheric nuisance; and (*c*) where atmospheric dust entering a plant may cause contamination of a product. The possibility of obtaining large flows of sterile air by filtration through 'Stillite' blocks was mentioned.

Dr. Hill reviewed the causes of dust production in the cotton industry and the problems arising therefrom. Operatives are liable to suffer from a respiratory disease known as byssinosis after long exposure to the dust liberated during the opening and carding operations. Little is known about the active agent in the dust, but it is evidently to be found in the finer fractions and may be histamine, lipoids, fungi or proteins which are potential allergens. The problem is one of removing the harmful dust without contravening strictly defined conditions of temperature, humidity, freedom from strong draughts and adequate access to machines.

Mr. Hellyer reviewed modern apparatus for the collection of dust from industrial gaseous effluents and for the cleaning of atmospheric air during conditioning. He dealt most fully with the design, operation and characteristics of electrostatic precipitators. A recent type, the 'Precipitron', was designed for air-conditioning plant. Ionization takes place in this precipitator at a potential of 14 kV. and

collection at 7 kV. Ionizing wires and charged plates are both positively charged, rendering ozone formation very small. A blackness test, using filter-paper disks, was described for measuring efficiencies. Numerous photomicrographs of industrial dusts were shown.

Points raised during the discussion on this session included the possibility of using oil treatment of the cotton during carding, recent experiments having shown very promising results. The high installation costs and the apparent drop in efficiency with time of electrostatic precipitators were mentioned by several speakers.

The three papers presented during the third session were "Practical Aspects of the Dust Problem, with Particular Reference to Flour Milling", by Leslie Smith; "The Dust Problem in the Photographic Industry", by R. G. R. Carnall; and "Surface Area in Dust Control", by P. J. Rigden.

Mr. Smith outlined present-day practice in dust control in flour-milling processes. High-speed exhaust systems with metal trunking and suction-type fabric filters are favoured. Current trends towards pneumatic conveyance of mill stock may necessitate installing complete air-conditioning plant.

Mr. Carnall presented the unique problem of preventing dust particles from reaching surfaces which could not be better designed to hold them. The solution lies in segregating dirty and clean work, providing special clothing for personnel and paying special attention to their health, forbidding the use of cosmetics and ointments, and using machinery as fully automatic and instrumented as possible. Bag filters, or the new 'Airmat' cellulose-wool filters, are used for air filtration because of their great reliability over long periods. Means of identifying dust particles embedded in photographic emulsions were described and illustrated by many photomicrographs.

Mr. Rigden described a method of measuring the surface area of dust samples, based on the well-known air-permeability method, but requiring samples of only 50 mgm. The pressure drop across beds of powder of sufficient length for accurate measurement is very high and necessitates special methods of measuring the flow of air. Direct weighing of air flowing through the bed into an evacuated bulb and the rise in pressure in such a bulb are the two methods used. Good reproducibility and agreement between the normal method using 10-gm. samples and the new method are attained.

Discussion during the third session showed particular interest in the methods used for dust suppression in the photographic industry. Many questions of detail were asked regarding the effect of sneezing and use of handkerchiefs and the precautions necessary during maintenance and overhauls.

The fourth session, which dealt with "Fire and Explosive Hazards", was held on the afternoon of September 29 under the chairmanship of Lieut.-Col. Sir Reginald Thomas. Six papers, which divided themselves naturally into three groups by their subject-matter, were presented, and discussion took place after each group.

The first two papers were "The Lower Inflammable Limit of Explosive Dusts and the Influence of Diluents Thereon", by Dr. J. E. Garside; and "Gas Explosions and Dust Explosions, a Comparison", by Elwyn Jones and A. Grenville White.

Dr. Garside described a method of determining the lower limit of inflammability of dust–air mixtures. The dust is dispersed by violently displacing into the explosion vessel a felt pad supporting the dust from a lead tube down which a detonation wave is injected from an exploding air–gas mixture. The method is used to show how the lower limit varies from material to material, is dependent on the grain size of the dust, and can be raised to a safe value by mixing inert powders, such as limestone, with the dust.

Mr. Jones maintained that flame propagation in dust explosions as well as in gas explosions is a thermal process capable of interpretation in terms of calorific value of the mixture. Impossibility of obtaining a perfect mixture of solids and gases complicates combustion in dust explosions. It seems that, at lower limits, solid particulate fuels are capable of forming local centres of ignition and propagation. An important factor in this process may be the volatility of the fuel. An appendix described an apparatus for determining limits of inflammability, which largely removes the influence of settling-rate of the dust.

In the discussion doubts were expressed about the validity of the results obtained in a laboratory-scale experiment when applied to large-scale explosions, and on the possibility of obtaining an accurate figure for the concentration of dust at the time of explosion.

The second group of papers comprised "The Ignition of Dust Clouds by Electrostatic Discharges", by Prof. E. G. Cox and A. G. Peace; and "Coal Dust Explosions. Recent British Experiments", by Dr. F. V. Tideswell.

Prof. Cox, describing work done during the Second World War, showed that many dust clouds might be ignited by electrostatic discharge. The incendivity of a spark depends upon its characteristics, and such a spark has an optimum incendivity when in series with a resistance of value depending on the capacity being discharged. Thus a discharge from a movable bin or from operatives which are badly earthed or from a charged body to an imperfectly earthed conductor is very liable to cause dust explosions.

Dr. Tideswell stressed the real danger of explosions due to coal dust not only in mines but also in pulverized fuel plants. Some amelioration of the danger in mines is to be expected from the increase in wet-cutting and the spraying of coal in tubs and at loading points. Powdered hydrates such as gypsum are more effective in suppressing dust explosions than shale dusts, and their use would increase the margin of safety given by the statutory stone-dusting requirements. Work is proceeding on specially free-flowing stone dusts which will be easier to apply continuously.

The final two papers of this session were "Explosion Reliefs on Dust Plant", by Dr. D. Matheson; and "Precautions Against Fire and Explosion" by G. V. Thom and G. A. V. West.

Dr. Matheson said that in the present state of knowledge the safest thing to do is to build a dust plant strong enough to withstand full explosion pressure, or place it where it can blow up without causing other damage. Work now proceeding should enable explosion reliefs to be designed which will safeguard existing types of plant from bursting through internal dust explosions.

Mr. G. V. Thom presented a very full survey of the explosion and fire hazards met with in chemical industry. He stressed the importance of properly maintaining fire-fighting appliances and of instructing personnel in their use.

A report of the proceedings of Section V of this Conference has already appeared in *Nature* (January 15, p. 111).

CHEMICAL CONSTITUTION AND BIOLOGICAL ACTIVITY

PROGRESS in the interpretation of biological results in terms of chemical constitution is very slow. Except in chemotherapeutic investigations, attempts to correlate physical and chemical data with activity on animal tissues have proved disappointing, even allowing for the relatively low degree of accuracy in biological methods and the too frequent absence of specific knowledge of the mode of action.

At the present time some advances have been made by using drugs belonging to a homologous series, or containing different elements but possessing varying degrees of similar pharmacological activity. Furthermore, lines of research have been directed with drugs having similar structures but showing protagonist and antagonist action. When Dr. F. Bergel delivered his address on "Some Aspects of the Relationship between Chemical Constitution and Physiological Activity" to the Fine Chemicals Group of the Society of Chemical Industry on November 26, 1948, at the London School of Hygiene and Tropical Medicine, he mentioned that too much must not be expected from one or two series of data disclosing only a fraction of the overall constitution. Once a working hypothesis of mechanism of action is established, correlation should be attempted between physico-chemical measurements and biological activities.

During the course of his address, Dr. Bergel showed that, in the consideration of the validity of the expression connecting physiological action of a drug and its chemical constitution (Crum-Brown and Fraser, 1869), it is necessary to include those events which precede visible pharmacological effects. The picture is confusing; but two working hypotheses help to elucidate the mechanism of drug action. In the first or receptor theory, certain areas of the cell at the site of action combine with the drug, and these combinations are the cause of the biological action. Many drugs such as anæsthetics, analgesics, and autonomic derivatives, acting rapidly and in high dilutions, may find their receptors on the outside of the cell surface, while those influencing cell division or growth may react with constituents of the protoplasm. Methylene blue, with its atropine-like and anti-bacterial effects, provides a clear example of both external and internal reactions. In the second or enzyme receptor theory (supported experimentally by such work on B.A.L., inhibitors of cholinesterases, respiratory enzyme systems, and amino-oxidases), a number of these receptors are said to be identical with functional enzymes or proteins. Then, on the basis of competitive affinity and mass action, an explanation is possible for the selective potency of stereoisomers, the increase of activity in homologous series, and the antagonistic action of certain drugs similar to protagonist molecules. The fact that low concentrations of many substances may produce physiological stimulation or depression while higher concentrations cause the reverse effect is, however, not easy to explain.

Turning to the chemical side, Dr. Bergel stressed that, only with models based on correct inter-atomic distances, van der Waals radii and valency angles, apart from geometrical and optical isomerism, can the compactness and spatial distribution of the atomic aggregate be appreciated. In addition, the existence of electrovalent, covalent and co-ordinate bonds, lone electron pairs, bonds with dipole moments adding up to polar groups and to polarization of the molecule, oscillating dipoles, resonance and hydrogen bonding, must not be forgotten. It has already been shown in some series that a certain bond-distance appears to be optimal for maximal effects. But disappointing results have been obtained from other aspects, and pharmacological chemists have therefore had to rely on rather more empirical approaches. The aim has often been to find a pharmaco-dynamic group, that is, the structural minimum which still carries distinct activity, and this type of method is well illustrated by work on synthetic analgesics, such as morphine substitutes.

G. B. WEST

GERMAN SOCIETY FOR DOCUMENTATION

CONFERENCE AT COLOGNE

BEFORE the Second World War, the International Federation for Documentation, then the International Institute of Documentation, included a German section which, afterwards, was converted into a purely German affair under the Nazi regime. A conference of the Deutsche Gesellschaft für Dokumentation took place in Salzburg in 1942.

During December 9–10, 1948, at Cologne, another conference was held, the first since the War, with the aim of finding the way back to the broader outlook which might once again open up possibilities of international co-operation in the field of documentation. It was a re-organised Deutsche Gesellschaft für Dokumentation which sponsored this Conference, together with the Deutsche Normenausschuss, the Verband der Bibliotheken von Nordrhein-Westfalen, the Arbeitsgemeinschaft der Technisch-Wissenschaftlichen Bibliotheken and the Verein Deutscher Archivare. The Conference was attended by some 150–200 delegates from different parts of Germany, representing universities, libraries, learned societies, the legal profession, designers of apparatus, and industrial bodies, meeting on board a middle-size river boat equipped as hotel and restaurant.

The opening session was presided over by Prof. Schmölders, who welcomed the delegates on behalf of the rector of the University of Cologne, Prof. Kroll. The main speakers of this session were Dr. Vollmer, director of the Staatsarchiv at Düsseldorf, and Prof. Corsten, director of the Stadt- und Universitäts-bibliothek at Cologne. It was followed by a business meeting of the newly constituted society, election of officers, the formation of sub-committees and so on. Lectures, open to the public, were given at the University of Cologne by Dr. W. Schürmeyer, president of the Deutsche Gesellschaft, Mrs. L. Moholy, representing the Library Association and the Royal Photographic Society of Great Britain, and Dr. Pierre Bourgeois, director of the Bibliothèque Nationale Suisse.

The emphasis of the lectures, papers and subsequent discussions was on the various aspects of microphotography, its growth and development, its progress in different countries, its use in archives, libraries and bibliographical centres, its importance for scholars, scientific and research workers, the copyright position, and so on. Two copyright experts, Dr. O. Runge and Dr. Wildt,

advocated the setting up of central agencies to simplify procedure (a suggestion also recommended in Great Britain), especially in cases where speed is essential. Prof. E. Reimer, another authority on the subject, was unable to attend.

To some extent the problems attached to the use of microfilms in Germany have been similar to those in Great Britain, though where the British often hesitate, the Germans have made quick decisions, and a variety of answers now strive for co-ordination. The requirements of *ad hoc* copying are distinct from those which govern organised reproduction; but any solution must keep within the provisions of a restricted economy. There seems to be scope for transparent as well as opaque material, flat shapes as well as long lengths, celluloid and 'Cellophane', high- and low-reduction ratio, microfilm with or without perforations, microcards, miniature prints, and so on, with the limitations mainly imposed by dearth of machinery.

To keep in check and, if possible, to standardize the existing variety of experimental methods, were among the aims the Conference set out to achieve. Apparatus, material and samples of work done were on view, to give practical backing to a number of technical points. It was, however, realized in the course of discussions that account must be taken of corresponding efforts carried on outside Germany, if international co-operation is to be restored, this being the other objective foremost in the minds of those who organised the Conference. The presence of foreign guests, including Mr. Donker Duyvis, general secretary of the International Federation for Documentation, to whom the Deutsche Gesellschaft für Dokumentation has now applied for re-affiliation, was welcomed as a hopeful sign in this direction.

L. Moholy

PHYSICS IN GERMANY

A DISCUSSION about the claims of technical physics to be regarded as a subject in its own right began at the International Congress for the Training of Engineers in Darmstadt in 1947, and has been carried on in *Physikalische Blaetter* (No. 8, 253; 1947. No. 1, 16; 1948. No. 3, 110; 1948), and is still going on.

Prof. C. Ramsauer, an eminent 'technical physicist' himself, founder and director of the A.E.G. Research Station, is emphatically opposed to the idea of technical physics as a special subject, although formerly there was a society devoted to it of which Prof. Ramsauer was president. Prof. Ramsauer states that during the First World War, both industrial and Government authorities were surprised at the superiority of 'pure physicists' over engineers in the solution of technical problems. Soon it was generally recognized that where new ground is to be tilled, it is not the routine of the engineer but the comprehensive grasp of fundamentals that assures success. The teaching of engineers, he believes, should be the same as that of all other physicists, supplemented in the advanced stages by technical courses not occupying more than one third of the total time, this total excluding mathematics and chemistry but including physical chemistry. The most grievous injury inflicted on German science by the Nazi regime was the substitution of the diploma examination for the doctor's dissertation; an examination deals with present knowledge whereas the thesis teaches the student to explore the unknown.

The opposite view has been advocated by Prof. Vieweg. He maintains that 'technical physics' must be a separate subject from the start. The technical physicist is a liaison officer between physics and engineering. Prof. Vieweg believes there should be mutual fertilization, and the term 'technical physics' expresses better than 'applied physics' this reciprocity. The task of technical physics is to loosen up and prepare the ground for technical development.

Prof. Ramsauer, after quoting replies to a questionnaire, most of which share his view, invites university authorities and industrial leaders to express their opinion about some concrete proposals which he sets forth. These include the demands that the term 'technical physics' should be completely dropped and that, as before, the doctor's degree should be the natural goal of every physicist's training. He calls this a matter of life and death for German science.

The Deutsche Physikalische Gesellschaft in der britischen Zone has declared at its board meeting of September 8, 1948, that it adopts the views of Prof. Ramsauer. It is of the opinion that there is no 'technical' physics, but only physics; technical physics is nothing but the application of pure physics to technical problems, and no special syllabus is required for such purposes. The Society considers that the introduction to technical mechanics and into electrotechnics should be taught at universities. Special technical problems ought to be dealt with in accordance with local conditions; however, they must not endanger the thoroughness of the general scientific education.

The obligatory doctor's dissertation is regarded as most important; its abolition during the Nazi regime was a great misfortune. The Society is most anxious that the 'diploma examination' should again be replaced by the 'doctorate examination'. In the meantime, it requests all authorities and firms to give preference to candidates who have obtained the doctor's degree. Gratification was expressed at the board meeting that its views are approved by the most important industrial firms.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, February 19

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S.W.1), at 10 a.m.—Discussion on "Layout and Planning for Radiographic Inspection".

Monday, February 21

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. H. G. Thornton, F.R.S.: "The Ecology of Bacteria with Especial Reference to Soil".* (Further Lectures on February 28 and March 14.)

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Dr. W. H. J. Vernon: "The Corrosion of Metals". (Cantor Lectures.) (Further Lecture on February 28.)

Royal Geographical Society (joint meeting with the Royal Society, at Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. Hans Pettersson: "Exploring the Ocean Bed".

Tuesday, February 22

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. W. G. Archer: "Primitive Indian Pottery".

Institute of Sociology (at the Royal Institute of British Architects, Portland Place, London, W.1), at 5.30 p.m.—Dr. G. Scott-Williamson: "The Family as a Basis of Society".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Automatic Precision Instruments" (to be opened by Dr. A. T. Starr).

UNIVERSITY OF LONDON (in the Department of Botany, King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. G. E. Blackman: "Modern Selective Weed Killers".•

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 6 p.m.—Papers on "The Spekker Photoelectric Absorptiometer and Fluorimeter".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the large Anatomy Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Annual General Meeting; at 7.30 p.m.—Discussion on "Process Research in the Fine Chemical Industry" (to be opened by Dr. H. J. Barber, Dr. G. M. Dyson and Mr. F. J. Bolton).

INSTITUTION OF THE RUBBER INDUSTRY, SCOTTISH SECTION (at the Chamber of Commerce Rooms, Charlotte Square, Edinburgh), at 7.30 p.m.—Dr. W. McG. Morgan: "Accelerators for Stocks containing Reinforcing Furnace Blacks, Part 1, The Scorch Problem".

Wednesday, February 23

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Dunstan Skilbeck: "Training for Agriculture".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (in conjunction with the SYSTEMATICS ASSOCIATION, at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. K. Airy Shaw: "Post-Darwinian Development of Taxonomy (Botany)".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Dr. W. J. S. Naunton: "Rubber and Chemistry".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL ENTOMOLOGICAL SOCIETY OF LONDON, at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 6 p.m.—Dr. Colin G. Butler: "Some Observations on the Sense Physiology of the Honeybee"; Mr. J. Pryce Jones: "The Origin, Composition and Properties of Honey".

Thursday, February 24

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Harold Hartley, F.R.S.: The Berzelius Memorial Lecture.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Evolutionary Aspect of Colour Vision" (to be opened by Dr. P. J. Pumphrey).

UNIVERSITY OF LONDON (in the Meyerstein Lecture Theatre, Westminster Medical School, Horseferry Road, London, S.W.1), at 5 p.m.—Prof. B. G. Maegraith: "Malaria as a World Problem".•

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the LOW TEMPERATURE GROUP of the PHYSICAL SOCIETY, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. E. W. Colbeck: "Materials of Construction for use at Low Temperatures".

CHEMICAL SOCIETY, HULL SECTION (joint meeting with the HULL AND DISTRICT SECTION of the ROYAL INSTITUTE OF CHEMISTRY and the UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Prof. M. Polanyi, F.R.S.: "The Nature of Scientific Convictions".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Prof. W. J. Duncan, F.R.S.: "Flutter and Stability".

CHEMICAL SOCIETY, NOTTINGHAM SECTION (joint meeting with the UNIVERSITY OF NOTTINGHAM CHEMICAL SOCIETY, in the Chemistry Department, the University, Nottingham), at 6.30 p.m.—Prof. C. A. Coulson: "The Shape of the Chemical Bond".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Dr. R. P. Linstead, F.R.S.: "Some Recent Developments in Organic Chromatography".

CHEMICAL SOCIETY, EDINBURGH SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Mr. R. C. Chirnside: "Analytical Chemistry, Chemical Analysis and the Analyst".

Friday, February 25

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

CHEMICAL SOCIETY, ST. ANDREWS AND DUNDEE SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Department, United College, St. Andrews), at 5.15 p.m.—Prof. C. E. H. Bawn: "Free Radicals and Hydrocarbon Chemistry".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Dr. P. Draminsky (Copenhagen): "Crankshaft Damping".

CHEMICAL SOCIETY, ABERDEEN SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Prof. D. H. Everett: "Some Factors Influencing the Strength of Acids and Bases".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Hans Pettersson: "Through Three Oceans with the *Albatross*".

Saturday, February 26

ASSOCIATION OF SCIENTIFIC WORKERS, AGRICULTURAL SECTION (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 3 p.m.—Dr. Audrey Richards: "Problems of Colonial Development—an Anthropologist's Point of View".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL SCIENTIFIC OFFICER in H.M. Nautical Almanac Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2404 (February 25).

PRINCIPAL SCIENTIFIC OFFICER in the Magnetic and Meteorological Department at the Royal Greenwich Observatory—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2402 (February 25).

METALLURGIST (Ref. F/EV.36), an ANALYTICAL CHEMIST (Ref. F/EV.46), an ASSISTANT CHEMIST (Ref. F/EV.47), and an ASSISTANT (with good honours degree, or equivalent, with physics as the main subject) (Ref. F/EV.48), in the Central Laboratory at Chiswick—The Staff Officer, London Transport Executive, 55 Broadway, London, S.W.1, quoting appropriate Ref. No. (February 26).

SENIOR LECTURER IN CHEMISTRY at the Military College of Science, Shrivenham, near Swindon—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.38/49A (February 26).

ASSISTANT KEEPERS (Class II) IN THE DEPARTMENTS OF CHEMISTRY, OPTICS, ASTRONOMY AND MATHEMATICS—The Director and Secretary, Science Museum, South Kensington, London, S.W.7, endorsed 'Assistant Keeper' (February 28).

BRADFORD DYERS' ASSOCIATION FELLOWSHIP for research on fundamental problems in the industrial processing of textiles—The Registrar, College of Technology, Manchester 1 (February 28).

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (February 28).

SENIOR LECTURER IN AGRICULTURE at Makerere College, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (February 28).

PRINCIPAL SCIENTIFIC OFFICERS, SENIOR SCIENTIFIC OFFICERS, and SCIENTIFIC OFFICERS, at the Royal Aircraft Establishment, Farnborough, Hants, for work in connexion with the planning of future aircraft projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.451/48A (February 28).

READERSHIP IN TAXONOMY in the Department of Zoology at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 4).

PROFESSOR OF GEOLOGY, and a LECTURER IN GEOLOGY—The Registrar, University College of South Wales, Cathays Park, Cardiff (March 15).

CHAIR OF PHYSIOLOGY at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (March 31).

LECTURER IN ACOUSTICS, and an ASSISTANT LECTURER, IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool (April 2).

BEIT FELLOWSHIPS FOR SCIENTIFIC RESEARCH—The Registrar, Imperial College, South Kensington, London, S.W.7 (April 2).

SENIOR LECTURER IN PURE MATHEMATICS, and a LECTURER IN APPLIED MATHEMATICS, at the University of Natal, Pietermaritzburg; and a SENIOR LECTURER IN APPLIED MATHEMATICS, at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.2 (April 11).

CHAIR OF GEOLOGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (April 16).

I.C.I. RESEARCH FELLOWSHIPS FOR RESEARCH IN PHYSICS, CHEMISTRY, BIOCHEMISTRY, ENGINEERING, METALLURGY, PHARMACOLOGY, CHEMOTHERAPY, or related subjects—The Secretary, Board of Research Studies, The Old Schools, Cambridge (April 30).

SENIOR CHEMIST TO THE RUBBER RESEARCH SCHEME (Ceylon)—The Chairman, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S.W.7 (April 30).

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH—The Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S.W.1 (May 14).

HEAD OF THE MATHEMATICS AND PHYSICS DEPARTMENT, Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1.

SCIENTIFIC ASSISTANT for information service and abstract journal—The Director, Commonwealth Bureau of Animal Breeding and Genetics, King's Buildings, Edinburgh 9.

SENIOR ENTOMOLOGIST and FIELD ENTOMOLOGISTS (3) in the East Africa Desert Locust Survey—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER IN THE DEPARTMENT OF CHEMISTRY, COLOUR CHEMISTRY AND DYEING—The Registrar, Technical College, Queen Street South, Huddersfield.

SENIOR ASSISTANT IN PHYSICS in the Darlington Technical College—The Chief Education Officer, Education Offices, Northgate, Darlington.

SUPERINTENDING PHARMACEUTICAL CHEMIST by the Government of the Federation of Malaya for Medical Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N. 18288.3F.

MINERALOGIST CHEMIST in the Geological Division of the Lands and Mines Department of Tanganyika—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ASSISTANT PROFESSOR who is an honours graduate in Mechanical Engineering, and LECTURERS (2) with honours degrees in Mathematics (one Lecturer with an honours degree in Electrical Engineering or an equivalent qualification, one Lecturer with an honours degree in Metallurgy or an equivalent qualification), at the Royal Naval College, Greenwich—The Secretary of the Admiralty (C.E. Branch 1), Admiralty, London, S.W.1.